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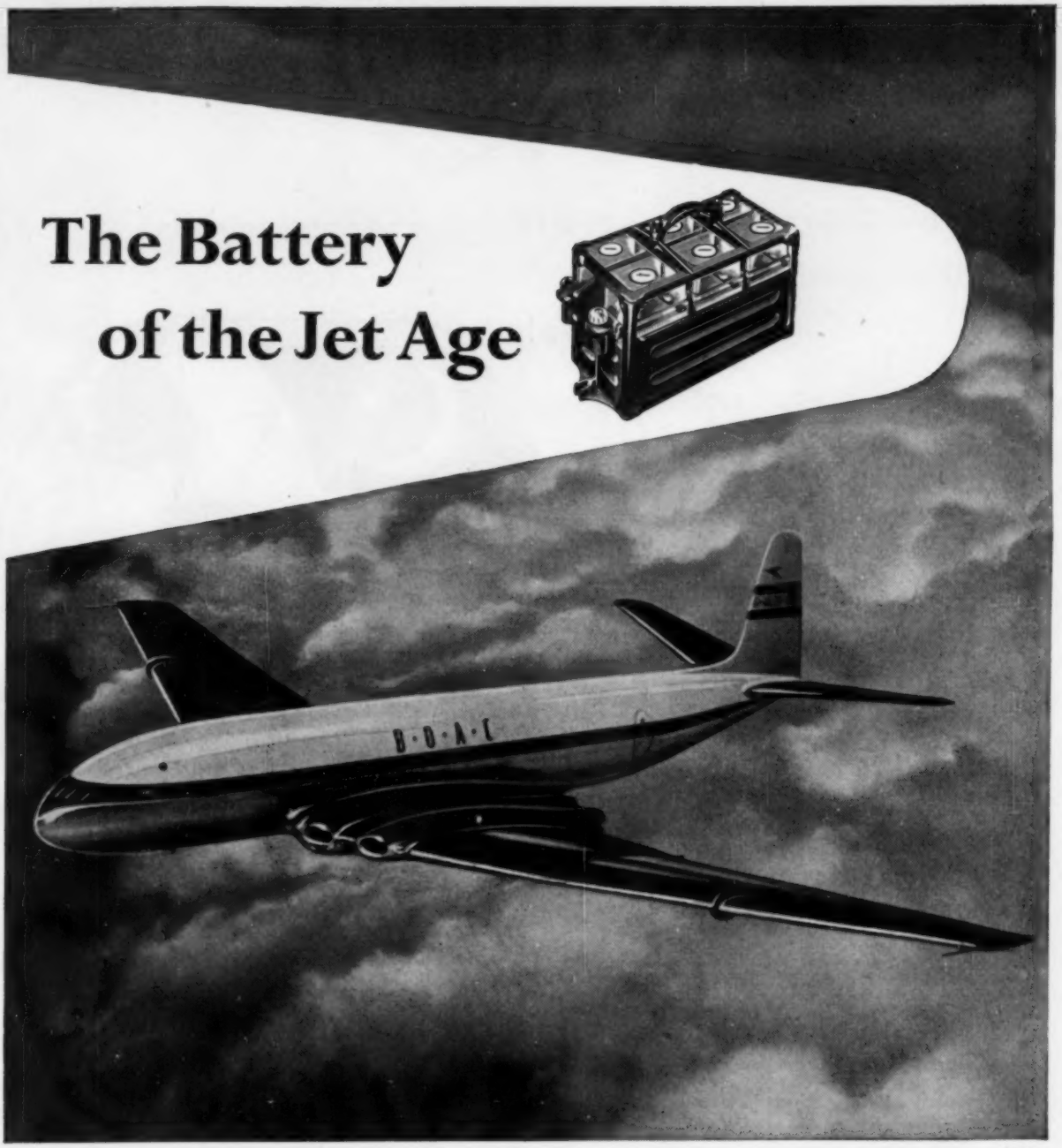

P.R.16

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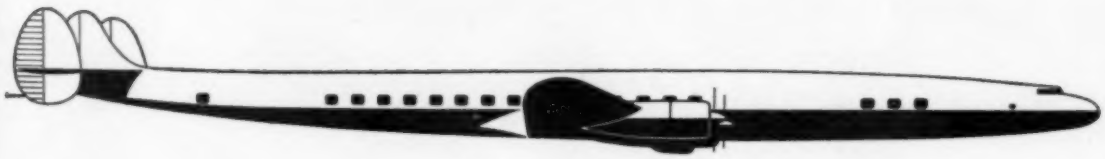

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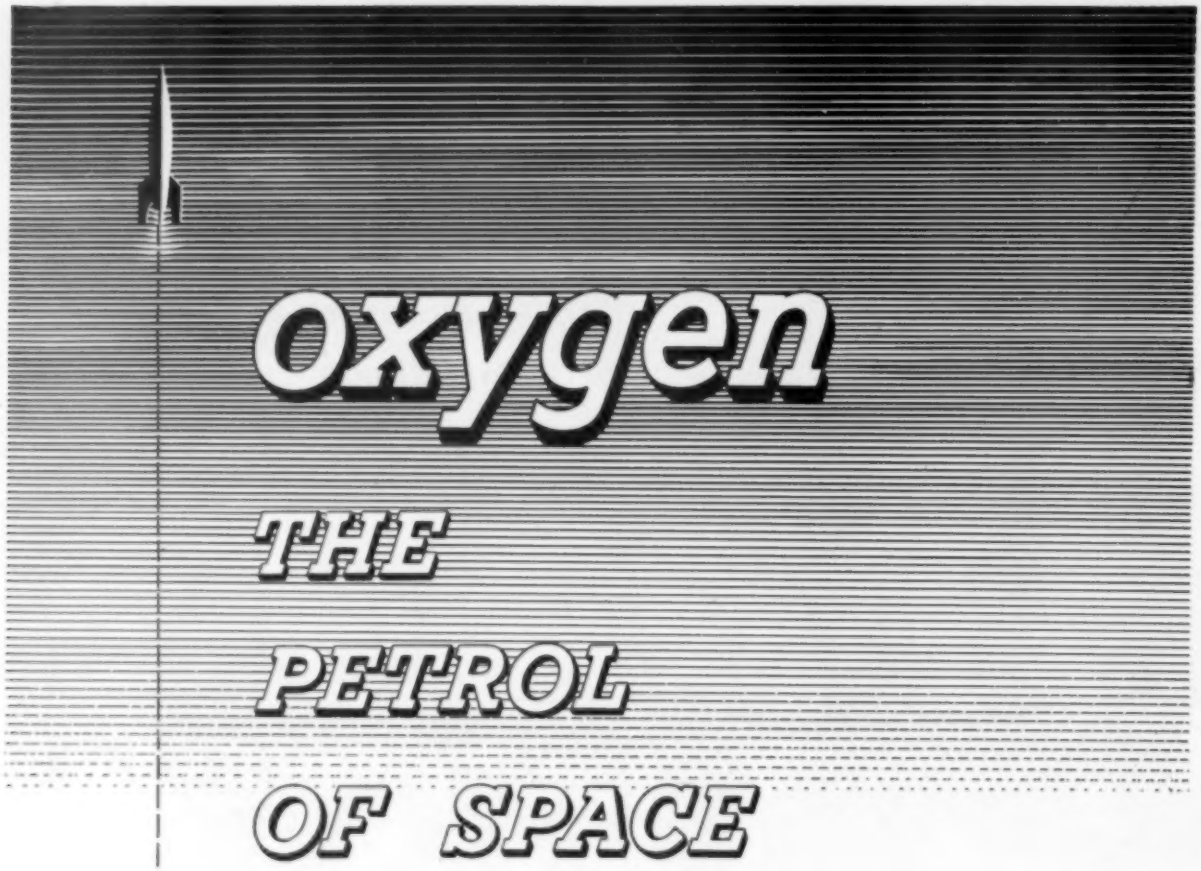

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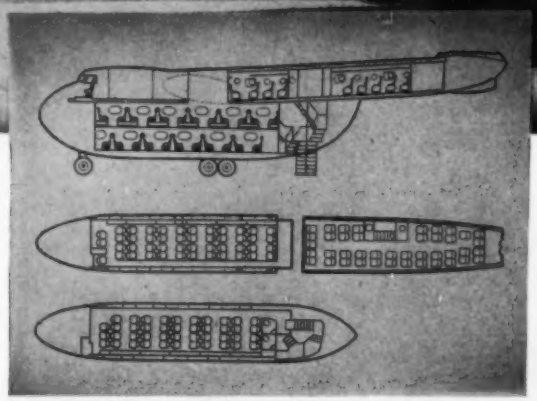

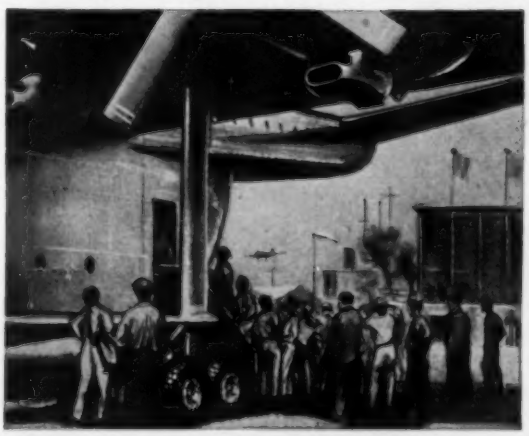

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UNITED AIRCRAFT EXPORT CORPORATION

THOUSANDS USING SABENA HELICOPTER PASSENGER SERVICE

In the first three months of operation, completed last November, Sabena Belgian Air Lines' new helicopter passenger service carried more than 3000 passengers on international flights. Eight cities in four countries are served by daily flight schedules originating in Brussels, Belgium. The airline relies on big Sikorsky S-55 helicopters, and four of the Bridgeport-built aircraft are now in use.

Passenger interest in the service is high, as indicated by a total of over 1600 persons carried in September (the first full month of the passenger operation) and the many requests Sabena has had to add new cities to its schedules. Four routes are served at present. These are from Brussels to Antwerp and Rotterdam, from Brussels to Lille in France, from Brussels to Liege and Maastricht, and from Brussels to Liege, Cologne and Bonn. Additional stops are planned.

Sabena estimates it will carry 25,000 helicopter passengers during 1954.

JET PRODUCTION INCREASES

During 1953 more than half the total engine horsepower produced by Pratt & Whitney Aircraft was in turbojets. For more than 14 months the company has been expanding to increase jet engine production, which is largely handled in its main plant at East Hartford. Thousands of new employees have been trained and are now at work in the jet program. A large part of the turbojet production is of 10,000-pound thrust class J-57 engines. Company officials pointed out a parallel in the U.S. airframe industry, where for the first time production of jet-powered airplanes also exceeded the output of piston-powered airplanes.

HAMILTON STANDARD PROPELLERS ON NEW AIRLINERS

Hamilton Standard Hydromatic propellers are now used on 90 per cent of all the world's commercial airliners, including the newest four-engined transports. They have been selected for the fast, new Douglas DC-7, and will equip 69 of 114 Lockheed Super Constellations now on order by 11 airlines.

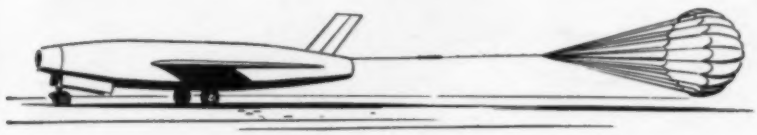
Hamilton Standard has entered its 36th year as the leading manufacturer of propellers and is now a supplier of other equipment for a growing number of U.S. Air Force and Navy jet combat aircraft. For example, on the big Boeing B-52 "Strato-

fortress," eight Hamilton Standard pneumatic starters and eight Hamilton Standard fuel controls go into action with every flight. The light, 37-pound Hamilton Standard pneumatic starter is also in new jet fighters, one of which is the North American F-100 which set a world record for level flight with a speed of 754.98 m.p.h. The starter develops 110 h.p. and performs the entire starting cycle in only 20 seconds. Beside fuel controls and starters, equipment made by the division includes air conditioning units and systems, hydraulic pumps and auxiliary drives.

To meet increasing demands for propellers and other equipment, and to continue its extensive development work, the company is now expanding plant areas to a total of over 1,000,000 square feet. Newest addition is at Broad Brook, Connecticut, where extensive existing buildings have been acquired for engineering work and light manufacturing operations.

REGULUS TRAINING MISSILES FULLY RECOVERABLE

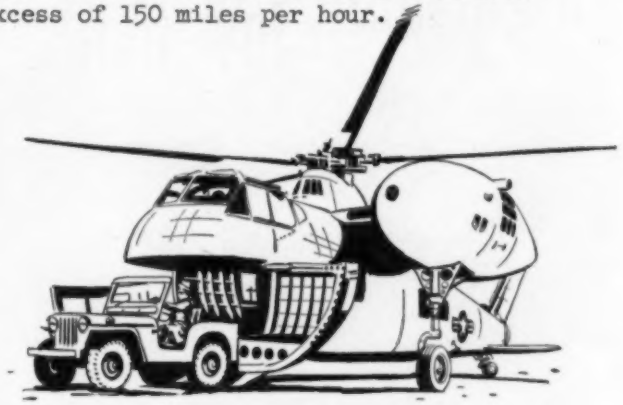
Training versions of Chance Vought's Regulus guided missile have been repeatedly launched, flown and landed. Exclusive recovery features perfected by Chance Vought have enabled Navy crews to make as many as 15 flights with a single missile. Training missiles have tricycle landing gear. A small parachute, mounted in a tail container can be popped to slow the landing roll. Missiles can be launched from submarines, ships or restricted shore bases.



BIG HELICOPTER DEMONSTRATED BY SIKORSKY

Sikorsky Aircraft recently demonstrated flight and loading characteristics of the new XHR2S helicopter which is now in production for the U.S. Marine Corps. As large as a Douglas DC-3 twin-engined airplane, the new rotor craft has flown with over 6500 pounds of payload, and at speeds in excess of 150 miles per hour.

Of particular interest are the wide, clamshell doors and built-in loading ramp which is lowered when the doors are opened. Jeep-size vehicles or artillery pieces can be rolled in or out of the long, unobstructed fuselage. The helicopter's two Pratt & Whitney Aircraft R-2800 engines are mounted outboard of the fuselage in pods on short wing stubs. This leaves the main body of the new aircraft open for cargo or passengers.



Production of the HR2S, other military models and the S-56 commercial version will be centered in a new branch factory to be built in Stratford, Connecticut. Several airlines have expressed an interest in the S-56 when it becomes available for commercial sale.

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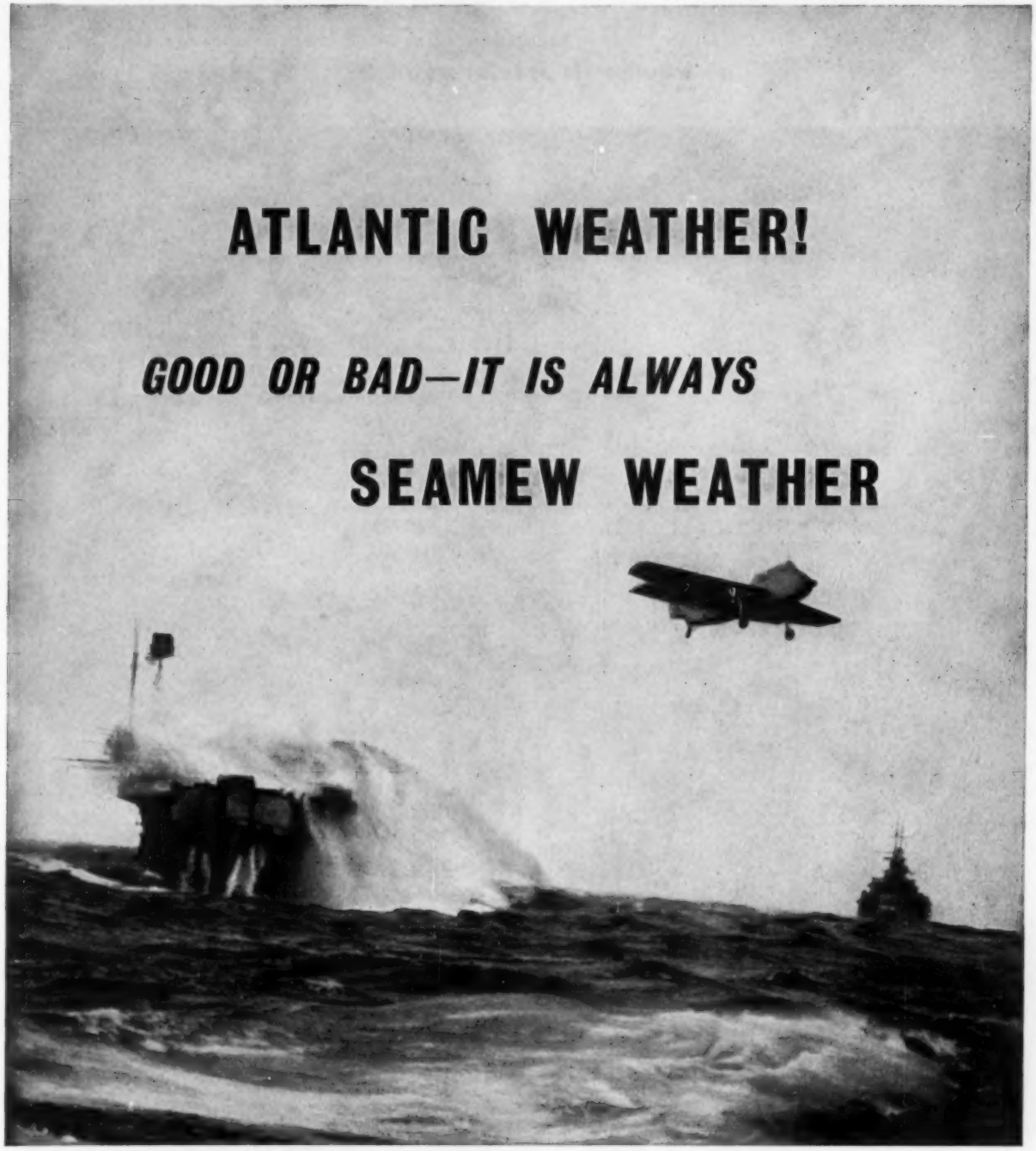

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No. 2 of a Series

Weather map symbol for Alto Cumulus

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The Peril in the Deep

A REMARK in our report last week of the handing over of the first Fairey Gannet carrier-borne anti-submarine aircraft to the Royal Navy must have jolted some readers as sharply as—we confess—it did ourselves. It was to the effect that the Gannet was the first Naval aircraft to be designed solely for anti-submarine work; and the deeper one ponders this curious fact (for it is curious indeed, having regard to the scale and bitterness of the anti-submarine battles of two wars) the more thankful one becomes that the Navy is at last beginning to receive its Gannets in quantity.

That Britain should have built such a potent weapon is as fitting as it is reassuring, for we have better reason than any other nation to recognize, and to arm ourselves against, the insidious peril of the under-sea raider; and that we were quick to appreciate the potentialities of the aeroplane as an anti-submarine weapon is vividly confirmed by an article appearing in the *Navy League Annual* of 1913-14, which runs: "There is one phase of utility for aeroplanes which deserves special mention, namely their efficacy as a guard against submarines . . . The aeroplane should be regarded as the 'four angels round my bed' of our childhood's prayers . . . both on the high seas and for coastal defence, the aeroplane as a detector and destroyer of submarines has a distinct place in the scheme of things." This, be it noted, was forty years ago.

In the Kaiser's War the short operational radii of our anti-submarine aircraft placed severe limitations on their employment. By way of armament, depth charges or anti-submarine bombs were adapted from existing weapons.

Between wars the technique of air-to-under-surface attack was little developed. It sufficed that anti-submarine bombs should be available, though experiments with heavy-calibre guns mounted in flying-boats were spasmodically revived.

The onset of the late war found the shore-based general-reconnaissance squadrons of the R.A.F. and the carrier-borne units of the F.A.A. still largely dependent on thin-case bombs for their anti-submarine attacks; but when the U-boat threat began to loom in all its grimness the depth charge was restored to favour, and as the war advanced new weapons and devices were introduced to swell the "a/s" armoury. Among them were Leigh lights, rocket projectiles, A.S.V. radar and sonobuoys—all of which had perforce to be applied to existing aircraft, in particular the Swordfish. A reversion to earlier practice was the introduction of the heavy-calibre gun, though this time in a fixed installation on the Mosquito.

Magnified Menace

With the introduction by Germany of the Schnorkel breathing-tube the menace of the submarine was greatly magnified, as this device allowed submergence for days on end. The answer (for, in the order of things, one was bound to be discovered) lay in the use of new, ultra-powerful and supersensitive radar, and in the provision of specialized aircraft. The first of these machines was the U.S. Navy's Grumman Guardian, hunter and killer versions of which were developed to work in pairs. Then Britain—as though to make up for past phases of antipathy—followed with brilliantly conceived "single-packet" machines capable of both tasks, and from these, after keen competitive trials, the Fairey design now known as the Gannet was chosen for production. With its twin gas-turbines, great stowage capacity, extensive field of view, and other attributes calculated to endear it to the Naval mind, the Gannet is pre-eminent in its class, and we are glad to pay it new tribute this week.

But so deadly is the modern submarine, and so diverse are its tactics, that the trend towards specialized aircraft and weapons grows yet more marked. Thus, for operation from escort carriers Britain has already ordered Short Seamews and—an even later manifestation of the Navy's determination to stay in the forefront of anti-submarine development—deck trials have been conducted both with the S-55 type of helicopter, as built by Westland Aircraft, Ltd., and with the twin-rotor Bristol 173. Though, pending the introduction of all-British helicopters, we shall use our newly acquired American machines with thankfulness, we may at the same time feel confident that native brains and ingenuity—irrespective of Allied efforts in the same field—are getting the measure of the deep-sea bane.

FROM ALL QUARTERS

The Loss of G-ALYY

WE record with deep regret the death of 14 passengers and a South African Airways crew of seven who were aboard B.O.A.C. Comet G-ALYY, lost while flying from Rome to Cairo on April 8th. The aircraft was operating a scheduled service from London to Johannesburg. It left Rome at 6.25 p.m. G.M.T. on April 8th and reported "over Naples, still climbing," at 6.57 p.m. Nothing more was heard from the Comet and in the early hours of April 8th the Italian Ministry of National Defence initiated an air-sea search. Later that day bodies and wreckage were sighted by aircraft, and the bodies of five passengers were picked up by the carrier H.M.S. *Eagle*. Only minor portions of the aircraft were recovered, and there is little possibility of further salvage since the depth of the sea in the area of impact (some 55 miles west of the Italian coast near Cosenza) is in the region of 3,000ft.

The accident occurred only 16 days after the resumption of Comet services by B.O.A.C. on March 23rd. There have been two previous instances of complete destruction of passenger-carrying Comets. On May 2nd, 1953, G-ALYV broke up in the air whilst flying from Calcutta to Karachi; the cause was not established, but extreme turbulence was suspected as a possible reason. On January 10th, 1954, G-ALYP disintegrated over the Mediterranean while flying from Rome to London. Magnificent salvage work by the Royal Navy resulted in the recovery of four-fifths of the wreckage of G-ALYP.

Intense efforts have been and are being made to establish a cause for these two accidents—by means of structural tests at Farnborough on the first prototype Comet 1 and by scrutiny of the remains of the aircraft.

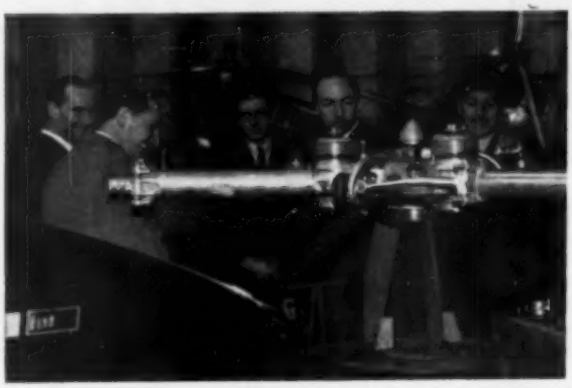
On March 8th, it was announced that B.O.A.C., with the approval of the Minister of Transport and Civil Aviation, would return their Comets to service after a minute examination of each aircraft and the embodiment of a number of modifications. These investigations have produced no definite clue as to the cause of the accidents. Following the loss of G-ALYY, it was announced on April 9th that the Minister of Transport and Civil Aviation had withdrawn the United Kingdom Certificate of Air Worthiness of all Comet aircraft pending further detailed examinations. This action followed consultation between the Minister, Mr. Lennox-Boyd, the Air Registration Board, the Air Safety Board and B.O.A.C. The de Havilland Companies, the manufacturers of the Comet and its engines fully concurred with his decision. Immediately after the accident B.O.A.C. suspended their Comet services and the five Comet 1-As operated by U.A.T. and Air France were also grounded on April 9th.

The South American services of B.O.A.C. have been temporarily suspended to enable Argonauts to take over the Comet routes to South Africa, Ceylon and the Far East. Permits to fly will be issued so that Comets at Cairo and Khartoum can be flown back to London (by volunteer crews) flying light in short stages at fairly low altitudes.

It is certain that flight tests will be made to supplement the work of the ground investigators, but the exact form these will take was not known at the time of going to press. As an initial step Comet G-ALYU was flown to Hatfield last Saturday and another Comet will probably be test flown by the R.A.E.

The investigations which are now under way, and which will continue as long as there is the faintest chance of discovering the cause of the three tragic accidents, comprise the most thorough examination of any aircraft yet built. Nothing but hard facts, based on this examination, can give the Comet a clean bill of health for the future.

Flight, while expressing hope and faith in the outcome, has no intention of adding to the speculations which have appeared in print over the past few days.



ROUNDABOUT: Mr. John Profumo, Parliamentary Under-Secretary to the M.T.C.A., inspects a Bristol 171 rotor head during a recent visit to Filton. Also interested are (left to right) Sir Reginald Verdon Smith, Mr. Raoul Hafner, Mr. A. E. Russell, Mr. J. L. Roberts, and Mr. R. S. Brown.

PULLING A SWIFT ONE: The delivery flight of the first Vickers-Supermarine Swift Avon-powered intercepters from the makers' airfield at Chilbolton (see also the opposite page) was led by W/C. H. Bird Wilson, D.S.O., D.F.C., A.F.C. The manner of emplaning in the Swift is very well shown in this well-composed study of the wing commander.

New Test Pilot for A.S.M.

NOW with Armstrong Siddeley Motors, Ltd., as an engine test pilot is F/L. A. Wittridge. He reinforces the flight team—E. Griffiths (C.T.P.), P. Aked and D. Griffith—at Bitteswell on test and development flying of the Sapphire and Viper turbojets and Double Mamba and Python turboprops. He has already flown most of the mounts in the company's flying test-bed stable, which includes a Sapphire-Hunter, a Dakota, Canberras, Meteors and Lancasters.

Albert Wittridge, who is now 31 years of age, trained in Canada during the war and served with fighter squadrons in the Far East. After two years with No. 616 R.Aux.A.F. Squadron at Finningley he completed the E.T.P.S. course, and was test flying at Boscombe Down until his move to Bitteswell.

The Mighty Mouse and the F-86D

EXTENSIVE tests of the intercepter fire-control system of the F-86D have been carried out over the past year by J. Ray Donahue, engineering test pilot of North American Aviation. As is well known, the F-86D is one of a number of American single-seat all-weather fighters: it is armed with twenty-four 2.75in Mighty Mouse rockets carried in a retractable pod under the forward fuselage. Test runs are made in clear weather, and towed on 6,000ft of cable by a B-45 Tornado. During the runs, a second F-86 flies alongside Donahue's aircraft as look-out and safety aircraft.

Donahue has for some time flown two sorties per day, making three or four actual firing runs each week. The system works as follows. Initial instructions are supplied by a G.C.I. station, and when within range the pilot identifies the "blip" of his target

GOOD LINES: Five Swifts—all, apparently, F.1s—on their marks at Chilbolton prior to being ferried away for the R.A.F. by pilots of that Service, accompanied, in this picture, by Supermarine test pilots Dave Morgan and Les Colquhoun. The Swift F.1s will be followed by more potent F.4s.

on his own radar screen. After a short period, the radar tracking and aiming device is "locked-on" to the target and from then on the whole attack is automatic. All computations are made by the equipment in the aircraft, and the necessary flight-path fed into an autopilot.

At the proper instant, the rocket tray is extended, and the 24 Mighty Mice blast their way to the target. The pilot then takes over manually and clears the firing area as quickly as possible.

The technique is slightly varied in the case of Donahue's tests, because initially he must be certain that his radar locks-on to the banner and not on to the towing aircraft. Before locking-on he must therefore wait until the "smear" of target and banner on his radar screen divides into two blips. Then, after the rockets have been fired, he holds the F-86D flying straight towards the target in order to obtain a full ciné-camera record of the attack, and passes within 300ft of the point of the rocket-bursts. The Mighty Mice themselves are armed only with "flash" heads, which have a minimum explosive effect but show up well on the film.

The significant factor is that attacks on this type of target must, for safety's sake, be made from as much abeam as possible, in order to avoid confusion between banner and target. In fact, it would appear that the F-86D is fitted with a system approaching what is known as the "collision course fire-control" which, ideally, is operated from a 90 deg beam cut-off vector, as opposed to the traditional stern-chasing attack.

R.Ae.C. Garden Party at L.A.P.

PURSUING its policy of changing the venue for the annual garden party, the Royal Aeronautical Society is to hold this year's event—on Sunday, June 13th—at London Airport.

The choice of a busy international airport may seem surprising until it is known that this year there is to be no flying programme (though it is possible that a transport aircraft may be available for flights by members and guests) and that the part of L.A.P. selected is the central area, near the new terminal buildings; it was here that the Royal Aero Club had its enclosure for the New Zealand Race.

For the first time since its purchase by the Society, the Nash Collection of veteran aircraft will be on view. It includes two Bleriots, a 1912 Caudron, a 1913 Maurice Farman, a Sopwith Camel, an S.E.5, a Fokker D.VII and two Avro 504s.

As is usual, tickets will be available only to R.Ae.C. members and their guests.

To Speed Production

MECHANICAL handling, in its lighter applications at least, is playing an increasingly important part in speeding production in aircraft, engine and aircraft-equipment factories. The industry's production engineers are sure to find plenty to interest them at the Fourth Mechanical Handling Exhibition, to be held at Olympia, London, from June 9th to 19th next. The Minister of Supply, Mr. Duncan Sandys, is to perform the opening ceremony.

Details have now been announced of the eleven papers to be read at the concurrent convention. Among those likely to be of interest to the aircraft and allied industries are the following: *Work Study and the Materials Handling Engineer,* by C. G. Chantrill; *Bridging the Handling Gap,* by John Bright; *Some Unusual Handling Problems,* by T. R. Mackie; *Economics of Modern Materials Handling with Industrial Trucks,* by R. B. Lister; and *Safe Use of Fork-lift Trucks in Industry,* by A. C. Cooper.

The exhibition and convention, which are held biennially, are organized by *Mechanical Handling* (Associated Iliffe Press, Dorset House, Stamford Street, London, S.E.1), with the support of trade associations. Tickets for the convention are available from *Mechanical Handling* or at the exhibition.

A.S.T.'s Chief Instructor Retires

WELL known to pilots of many nationalities who received their flying instruction at Air Service Training, Hamble, W/C. H. A. C. Stratton, A.F.C., the chief instructor, has retired. S/L. G. Webb, A.F.C. and Bar, another A.S.T. instructor, takes over the post.

Henry Stratton joined the organization in 1937, after 14 years' service in the R.A.F. As a staff instructor at the Central Flying School, he was one of the first Service instructors in instrument flying, and for three years he appeared at Hendon and other air displays as a member of the famous C.F.S. team which performed inverted aerobatics in Avro Tutors. With the coming of war he rejoined the R.A.F., later commanding training schools in this country and Canada, and was eventually posted for test-pilot duties with the Ministry of Supply. He carried out the advanced aerobatic and spinning trials of, among other aircraft, the Avro Athena trainer. On leaving the Service in 1950, W/C. Stratton took over as general manager and chief instructor at the flying school in Karachi which Air Service Training was operating for the Royal Pakistan Air Force; and two years later he returned to Hamble as the company's chief flying instructor.

S/L. Webb, who is 45 years of age, joined the R.A.F. as an apprentice in 1925. He learned to fly in 1930, and joined A.S.T. as an instructor in 1938. He returned to the Service during the war, and among the posts which he held was that of C.O. of No. 1 Beam Approach School. He rejoined A.S.T. at Hamble in 1947. He has 10,450 hours' flying in his log-book.

W/C. Stratton (standing) and—right—S/L. Webb, his successor.

"FLIGHT"
photographs

Now flying with the Royal Navy are the Gannets of 703X Flight, commanded by Lt-Cdr. F. E. Cowtan. (Below) A smart line-up at Ford together with the veteran "Stringbag." (Left) WN 349 peels off. (Above) A trio over Sussex on an April morning. (Right) Purposeful, powerful: the flight in echelon. (Lower right) A wing-folding salute for Fairey and R.N. "top brass" after the inaugural fly-past at Ford. One half of each A.S. Double Mamba is shut down, and the airscrew feathered—the flight condition for economical cruise.

GANNETS AT WORK

THE Navy's first flight of Fairey Gannet anti-submarine aircraft, stationed at Ford, Sussex, is at present being subjected to a most rigorous series of intensive-flying trials. As reported last week on the occasion of the handing-over of the aircraft log-books by Sir Richard Fairey, the commanding officer of the new 703X flight is Lt. Cdr. F. E. Cowtan, and on these two pages we present further pictures—taken from a Firefly—showing his crews and aircraft in action.

The new flight is attached to 703 Squadron Service Trials Unit, and its present flying programme is planned to determine the technical and operational performance of the aircraft and equipment under continuous-flying conditions. On the engineering side, a two-watch system whereby maintenance is carried out at night after the day's flying ensures that the aircraft are ready to fly first thing each day, and an impressive utilization has been achieved. Indeed, it appears that the possible limitation of flying hours will be due to pilot-fatigue rather than any fault in the aircraft. Maintenance snags have been relatively few: although the Gannet is a complicated aircraft, the standard of its detail design is

high, and thus the complication has caused few troubles in service. In addition, the aircraft is not unknown to naval maintenance personnel, a Gannet S.M.P. (special maintenance party) under Lt. Cdr. (E) T. G. F. Hardy, B.Sc., D.C.Ae., having been working in close collaboration with Faireys for some time.

The present strength of the Flight includes (in addition to the Commanding Officer) Lt. Cdr. A. D. Cassidi, Lt. S. F. J. McGrail, and Lt. C. G. Vickers (pilots); Sub-Lt. T. D. H. Coombes, Sub-Lt. A. E. Cutting, Lt. J. H. Hawker, Sub-Lt. K. L. Palmer, and Lt. D. C. Pratt (observers); Lt. Cdr. T. G. F. Hardy and Commissioned Air Engineer T. R. E. Beabey (air engineer officers); and Lt. (L) M. K. Falkner (air electrical officer).

It was during the preliminary flight trials of the Fairey GR 17/45 (the original version of the Gannet) that a major internal reorganization took place within the parent company. In addition to improving administration, this enabled rapid progress to be made when the production contract was awarded on March 14th, 1951.

Since that date the production story of the Gannet has shown an exceptional effort by Fairey personnel. On repeated occasions, many worked overnight to keep to a scheduled delivery date, and carrier trial dates were always kept over the whole of the development period. With Gannet production continuing to flow, further deliveries to the Navy should enable the first squadron, after working-up, to join a carrier late this year.

For the record, the Gannet AS.1 is powered with an Armstrong Siddeley Double Mamba turboprop, and carries a crew of three. The radar scanner is retractable into the fuselage, aft of the quite remarkably capacious weapons bay. The Fairey-designed undercarriage permits a very high rate of descent to touch-down.

CIGAREETS AND WHUSKIE—or at least smoke and alcohol—are factors in the improved take-off performance of the Boeing B-47 bomber, as explained in a news item on page 494. The close-up picture shows the "collar"-type rack with 33 JATO units, each of 1,000 lb. thrust, in place.

HERE AND THERE

Hustler Power

THE power-plant of the Convair XB-58 Hustler supersonic delta bomber is likely to be four General Electric J79 turbojets, each delivering about 15,000 lb thrust dry. They will be installed in pods.

Cheaper and Quicker

ACCORDING to a report from Sydney, people living in the country surrounding Broken Hill regularly charter Auster air taxis for visits to the mining town's cinemas. It costs them 1s 6d a mile, as against 2s by a road taxi.

Rover Turbine Production

As it is now some years since the Rover company began to develop small gas turbines, it is most heartening to record the fact that these units are going into production. Two basic types are to be built: a single-shaft 60 h.p. unit and a free-turbine engine with heat-exchanger. The latter will be suitable for transport applications—possibly including aircraft—while the single-shaft engine is principally for stationary industrial use. The 60 h.p. engine has a single-sided centrifugal compressor, with a pressure ratio of only 2.9 : 1. The fuel system is a Lucas/Plessey development, with spill burners, feeding any standard fuel to a single combustion chamber. At 46,000 r.p.m. the overall thermal efficiency is 9.5 per cent, and the s.f.c. 1.46 lb/hr/b.h.p. The bare engine weighs about 116 lb dry.

Offshore Migs.

REPORTS reaching Formosa indicate that a large new jet aircraft factory, the first in China, is to be constructed at Hangyang, near Hangkow, known in Nationalist times as "the arsenal of China." £35m of Russian capital and 150 Soviet experts and technicians will be lent for the project. The financial loan will be repaid in goods.

Foreign Aid Fund Allocations

ACCORDING to a statement to the American Senate foreign affairs committee by Mr. Harold Stassen, Director of Foreign Aid, $75m (£26,785,000) in requested funds have been earmarked for British aircraft production for the R.A.F. No further funds have been allocated for French aircraft production. It will be recalled that Mystère IVs were ordered off-shore last year, and the first machines are now coming off the production lines.

R.N. Air Day

H.M.S. GAMECOCK (R.N. Air Station Bramcote, near Nuneaton, Warwickshire) gives well-advanced notification that its annual "at home" is to be held on Saturday, July 3rd. Naval charities benefited by over £1,000 from last year's event. *Flight*, incidentally, is always glad to hear from organizers of forthcoming flying displays, so that their dates may in due course be included in "Forthcoming Events."

Aeronautical Art Exhibition

SOME fine paintings of aircraft, including the Britannia, Comet and Viscount, are to be seen at the one-man exhibition open until April 24th at Biddle's art shop, 164 High Street, Guildford, Surrey. The pictures are the work of David Shepherd, a promising young artist with an individual, realistic style. His principal patrons to date are B.O.A.C., Vickers and K.L.M.

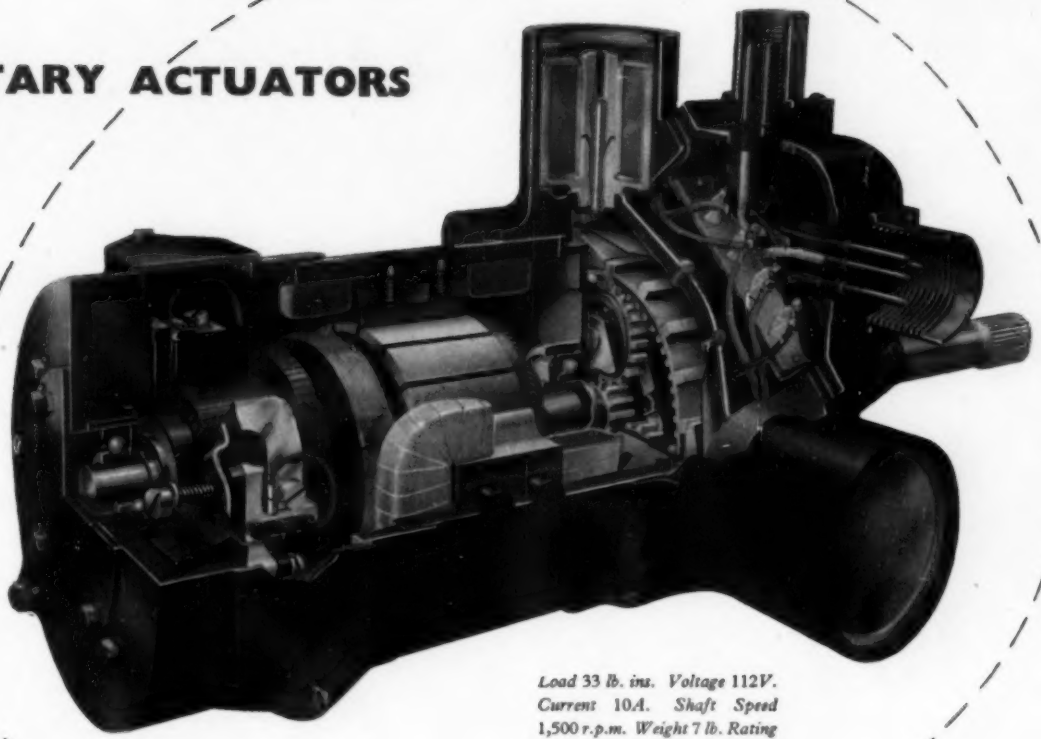
Active Retirement

INSTRUCTOR and test-pilot George Lowdell, in 32 years' flying, has served in one or other of those capacities with the R.A.F., the Suffolk Aero Club, Brooklands School of Flying, Wolseley Aero Engines, Reid and Sigrist and Vickers-Armstrongs. Now, at 54, he has embarked on a new career—as mine host of The Chequers, at Slaugham, Sussex, just off the London-Brighton road near Handcross

POWER PACKAGE: As reported above, the Rover 1S/60 shaft-drive turbine is now in production. Here, the 60 h.p. set is arranged to drive a water pump, with hose attachment, the whole in a carrying frame.

MR. I S. SHENSTONE, chief engineer of B.E.A., presents a prize to J. E. Toplis, best all-round apprentice at the Corporation's engineering base. An R.Ae.S. lecture by Mr. Shenstone, summarized on p. 490.

ROTARY ACTUATORS



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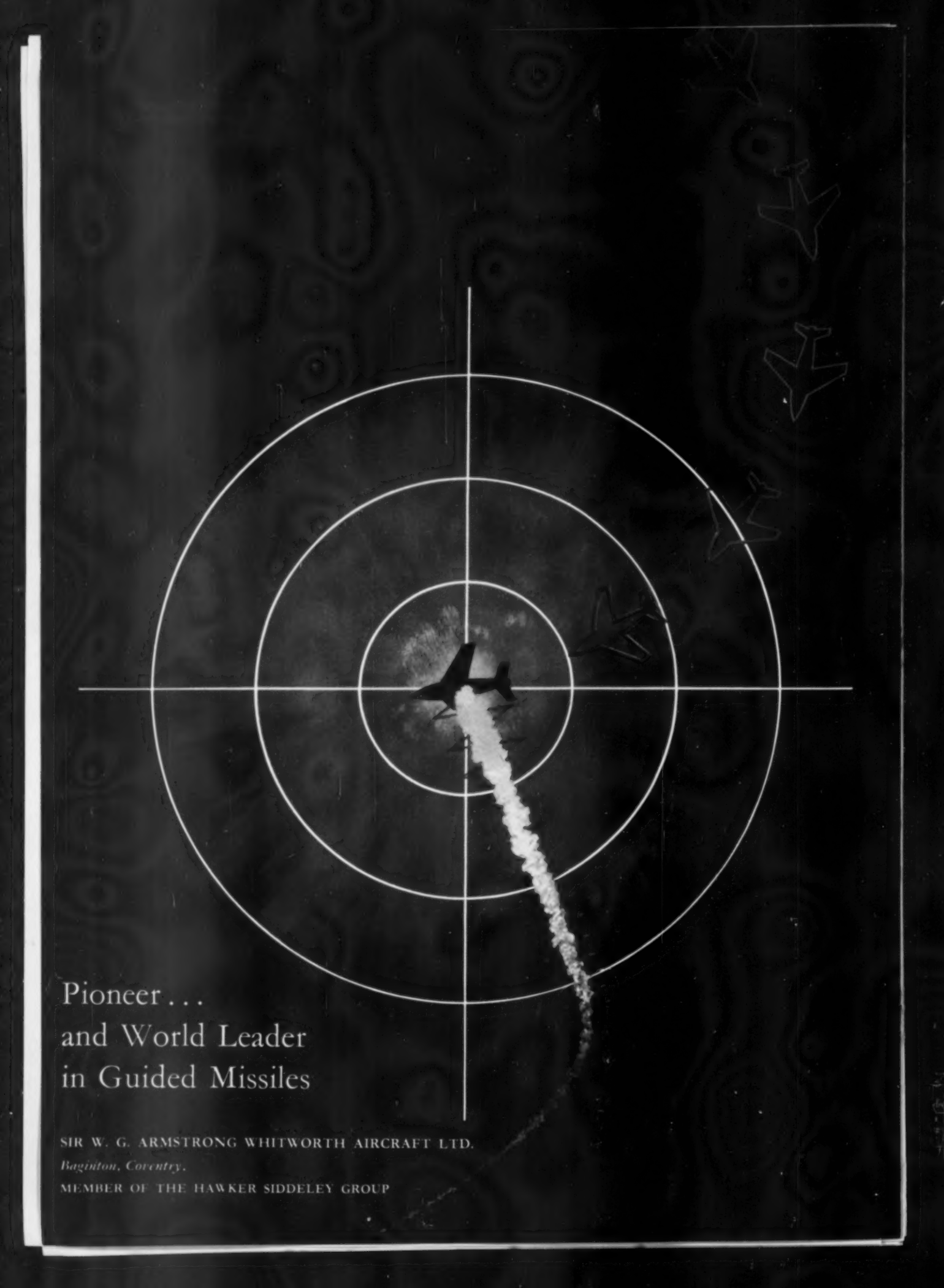

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WHAT AN AUSTRALIAN WANTS

—*as Equipment for the R.A.A.F.*

By STANLEY BROGDEN

THE author of these critical views on the most suitable types of fighter, bomber, reconnaissance and transport aircraft for the Royal Australian Air Force has been Public Relations Director of that Service since 1950, and holds the Reserve rank of group captain. He emphasizes, however, that the opinions expressed here are personal.

AN air-minded Australian planning a visit to Britain has one of two viewpoints—Service or civil. The thoughts that follow are from the first of these two.

The Service Australian will have formed a picture of British progress in military aircraft from what he has read and seen. Britain has such a lead in jet engines, for instance, that he will expect to see the world's finest turbojets; of this he has had some preliminary experience, for he has seen the Avon going into production with Commonwealth Aircraft Corporation.

But what will he learn about the aircraft Britain has to offer the Royal Australian Air Force? This is another matter entirely.

The R.A.A.F. has its own replacement problem. First, a decision may soon be taken on the new transport type to be introduced. R.A.A.F. requirements are for a type which will take a truck or tank through the nose; they fill, more or less, the specification for an Army assault transport. The Chase C-123B is precisely the type the R.A.A.F. needs. Many R.A.A.F. veterans of Korea saw the Packet in action and did not regard the sight as a privilege. The Blackburn and General Beverley is too big; there is simply no peace-time rôle for such a large transport in the R.A.A.F.

I would like to see a British assault transport in the Chase class, or perhaps one like the Nord 2501 Noratlas. The R.A.A.F. today needs such an aircraft more urgently than any other type. Its only existing transports are Dakotas. If Britain had a Chase, proven and in production, the R.A.A.F. would probably—I am going to say certainly—order eight to a dozen, according to price. The R.A.A.F. would expect to pay some £200,000 sterling without spares.

The constant delay on Chase production, and the rumoured bugs in the C-123B, plus the general reaction to the Packet, make it possible that the R.A.A.F. will either carry on with Dakotas or compromise on some type not really suitable for its particular needs, such as the Bristol Freighter.

I would also like to see a British fighter in the F-100 class—supersonic with range. Appeals to Australia to make the Hunter or Swift will be useless, for our requirement is for range as well as speed. The U.S.A.F. F-86 Sabre, I believe, has a combat radius of 500 miles. What has the Hunter or Swift? Our fighter requirement has always been, and is likely to be, the same as that of the U.S.A.F. Pure intercepters just do not have a rôle in Australian defence.

The R.A.A.F. must take a decision within the next two years about its Avon-Sabre successor. The simple answer is to produce the F-100, which North American are quite willing to let us do. Commonwealth Aircraft Corporation have produced only types designed by North American Aviation since the Wirraway (developed from the Harvard) was selected as the first Australian-produced aeroplane 18 years ago.

I would like to see a British fighter with a Mach number of 1.25 and plenty of range, armed with two or four 30 mm cannon. Why British manufacturers have not designed such an aeroplane at this stage for the R.A.F. to operate in the Middle East and for NATO is beyond many Australians. You have simply accepted the fact that the R.A.F. must secure F-86s for the long-range fighter rôle. Is that a permanent policy?

Meanwhile, do not expect Australia to buy short-range fighters or to build them. If the R.A.A.F. had maintained an original decision to build the P.1081 here it would have been a mistake; from our point of view the Avon-Sabre is superior in every way. By accepting the F-100 we would again secure a proven airframe and type, with the range and speed we require, and the C.A.C. team would be happy in continuing their North American contacts.

Will I see something in Britain which will change this forecast? I doubt it.

As a long-range interest, I would also like to see a replacement for the Neptunes and "long-nose" Lincolns in our maritime squadrons. Surely, the answer here might be a turbine-powered flying-boat—something on the lines of the Consolidated-Vultee maritime reconnaissance flying-boat now being publicized in the U.S.A. I am told that several British manufacturers have designs of such a type but are having no joy out of Air Ministry.

A Catalina successor, with 300-400 m.p.h. and up to 20 hours' endurance, might interest the R.N.Z.A.F. also; it should be worth-while designing. The trouble from the R.A.A.F. viewpoint might be cost, which places the most attractive Britannia (R.C.A.F. version) out of Australia's reach.

Whenever a British designer thinks of Australian Service needs he should remember that the R.A.A.F.'s annual income is about £40,000,000 sterling, which includes cost of aircraft purchase. This does not allow of Britannias and Comets.

This cost factor makes quite a problem of our Canberra replacement. There is no light bomber in sight anywhere as a Canberra replacement, of course, and the very requirement seems to have died. The ideal—as was, in fact, outlined by Air Marshal Sir Donald Hardman, K.C.B., O.B.E., D.F.C., before he returned Home after two years as R.A.A.F. Chief of Air Staff on loan from the R.A.F.—is to buy medium bombers in the V group.

I would like to see something a little cheaper than the V group, perhaps more of the B-47 style—something Australia could buy in the half-million (sterling) bracket, with plenty of range.* This would give us immense hitting power and allow the Canberra to be a reconnaissance and ground-support type.

So much for actual types and aeroplanes. Many Australian visitors of an air-minded nature would like to be convinced that Britain was not some years behind the U.S.A. in the ultra-supersonic bracket. We have heard a good deal of the Bell and Douglas and other flying test-benches for Mach 2 flight, but nothing from the British end. Is Britain lost here, or merely secretive? The younger generation in Australia is mightily impressed by these newsreels of Americans flying at 1,250 m.p.h., even from a B-29 for a few seconds.

** We believe that the B-47 costs about half as much again as the Valiant, in spite of large-scale production—Ed.*

REMOTELY CONTROLLED HELICOPTER

A PIASECKI twin-rotor HUP-2 has been remotely controlled to hover over a desired point at a desired height. According to *American Helicopter*, the completely automatic method employed enabled the machine to maintain its horizontal position to an accuracy of better than 5ft.

"A small transmitter," runs the report, "was installed in the helicopter. Signals from two Raydist relay stations on the ground were compared in one phasemeter to indicate longitudinal movements of the helicopter, while signals from two other relay stations were compared in a second phasemeter to indicate the transverse movement.

"The transducer for each of these error indications was a small low-torque potentiometer attached to the shaft of the respective phasemeters. As the helicopter, hovering over the reference point, tended to drift to the left or right of the reference point, the transverse phasemeter indicated the movement as rotation which actuated the arm of the potentiometer and introduced positive or negative signals to the autopilot. The autopilot then adjusted the cyclic pitch of the rotor blades to reposition the helicopter in such a manner as to bring the phasemeters back to the null position. Fore and aft digressions were handled in a similar manner."

HELICOPTER NAVIGATION

Problems of Future Operation Discussed in Helicopter Association Lecture

NAVIGATIONAL problems peculiar to helicopter operation formed the subject of a lecture given before the Helicopter Association in London by Mr. D. M. Davies, M.A. (senior helicopter project engineer, Fairey Aviation Company), on Friday last, April 9th. In general, the paper began, these problems lay in the future; so far, helicopter operations in this country had been on a small scale, using small aircraft, and in the majority of flights sight of the ground had not been lost other than momentarily. It was therefore necessary to generalize from insufficient data, especially as the performance and flying characteristics of the next generation of helicopters were uncertain.

The helicopter was a short-range vehicle, for stage-lengths up to about 250 miles. Thus, techniques such as astro-navigation and pressure-pattern flying were of no practical importance. The main problems of helicopter navigation over short stage-lengths were probably connected with (a) radio or other navigational aids needed; (b) air traffic control; and (c) D.R. navigation.

Dealing first with D.R. navigation, the lecturer stated that the uncertainties of this technique arose from errors in maintaining course and air speed (associated with the aircraft/pilot combination) and from errors in mean wind velocity, which were not necessarily associated with aircraft behaviour. An investigation into the D.R. navigation of helicopters had recently been conducted by B.E.A. with M.o.S. and M.T.C.A. support, and specific characteristics had been examined.

Concerning the possibility of inadvertent application of yaw on the Bristol 171 and Sikorsky S-51, it had been found that this was not a serious problem. It was unlikely that liability to yaw would present a future problem at cruising speed—the flight condition important for navigation—particularly as forthcoming designs would probably have more directional stability.

The performance of the magnetic compasses fitted to the helicopters had been studied. It was found that the original compass on the Bristol 171, which was a P.12 type, gave errors up to 20 deg in flight, although a ground swing showed only small errors. This was due to a combination of aircraft vibrations and faulty suspension springs. The P.12 had been replaced by an E.2A compass, which had given satisfactory service.

No direct checks of the A.S.I. installation had been made, but Boscombe Down had calibrated both machines with an air log. Errors at cruising speed were small, and appeared consistent, but appreciable differences occurred between level flight, climb and power-off descent.

The vibration spectrum to which rotating-wing aircraft were subject affected the life and possibly the behaviour of flight instruments. Large-amplitude low-frequency vibrations associated with the main rotor were present, and special protection was sometimes needed.

It was generally accepted that helicopters were more difficult to fly than comparable fixed-wing aircraft. This implied a higher level of concentration to achieve a given standard of accuracy of instrument flight; alternatively, if this higher level were not maintained, the pilot's accuracy would suffer. It seemed that an improvement would appear with future types of helicopter, which should be acceptably stable at cruising speed. In this case, pilots should be able to fly blind with a facility approaching that on fixed-wing aircraft, and present indications were that this would be done on a more or less normal blind-flying panel.

A complete solution of blind-flying problems throughout the speed range, however, was not in sight. There were three factors, apart from instability, which made instrument flight difficult at speeds below the minimum power speed. The first factor was that on existing small designs the power required for level flight decreased sharply between about 5 and 35 kt. A similar rapid change of power appeared to be inescapable on future designs. This meant that a pilot flying at these speeds might be faced with major corrections to engine power for a small speed change, to maintain steady flight, apart from controlling the attitude of the aircraft.

The second factor was that fuselage attitude—and therefore the indication of the artificial horizon—changed under varying flight conditions in a manner likely to bewilder a pilot trained on fixed-wing aircraft. For example, the Bristol 171 adopted a nose-up attitude during descent, while if the descent was broken off and the machine climbed away (a type of overshoot) the fuselage was nose-down, particularly during accelerated flight. The pilot had in fact to learn all over again what the pitch indications of the artificial horizon meant.

The third factor was the need to maintain rotor r.p.m., and hence lift, by manual control of collective pitch. In steady flight, only minor co-ordinations of throttle and collective pitch were required, but when changing from, say, level flight to descent, the co-ordination might occupy much of the pilot's attention.

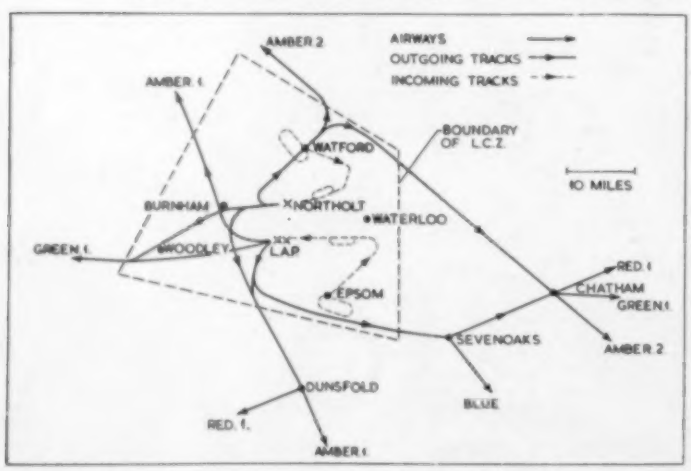
The general conclusion concerning overall accuracy was that there was no reason to expect large errors in the D.R. navigation of helicopters compared with the errors on fixed-wing aircraft operating at similar speeds. In order to confirm this, a series of cross-country flights was made over distances up to 100 miles with the Bristol 171 and the Sikorsky S-51. The flight plan was drawn up initially on forecast winds, and during the course of the flight a revised wind was estimated and used to compute a revised course and E.T.A. The opinion of all pilots concerned was that the *en route* corrections were of normal magnitude, and that the selected courses and speeds could be held satisfactorily. Quantitative data obtained on subsequent flights confirmed that the standard of accuracy in the D.R. navigation of helicopters compared not unfavourably with the fixed-wing standard.

Turning to navigation aids, the lecturer pointed out that such assistance must be associated with the purpose for which the helicopter was going to be used. It was generally accepted, Mr. Davies thought, that the ability to fly blind and at night was essential for air transport operations. In very low traffic, however, where regularity and punctuality were relatively unimportant, no aid was necessary. As an intermediate stage, V.H.F/D.F. was probably adequate, while in the crowded air space of the U.K., where operators worked to tight schedules, comprehensive radio aids were required.

The navigator's problems then fell into two types: those experienced *en route* and those associated with landing and take-off. When the aircraft was *en route*, the radio aid should enable the crew to proceed to a position close to their destination and should enable their position at any time to be determined with sufficient accuracy to forecast time of arrival, to avoid high ground and for the purposes of air traffic control.

As with fixed-wing aircraft, a choice had to be made between the type of aid which provided a fix, and the type which provided a radio range. It appeared that, instead of serving a relatively small number of fixed-wing airfields associated with large towns, the helicopter would need to serve a much larger number of sites. Since it would be difficult to lay out radio ranges to serve such a complicated network properly, the "fixing" type of aid, which inherently had more flexibility, might be favoured.

Another point was that the helicopter flew at low altitude: this favoured an aid which did not use high radio-frequencies. The



An illustration of the London Control Zone, from Mr. Davies' paper, showing probable incoming and outgoing tracks for fixed-wing aircraft using Northolt and London Airport in a westerly wind. The effect of helicopter operation in the zone is discussed by the lecturer.

available radio aids were: (1) M.F. beacons (the aircraft carrying a radio compass); (2) V.H.F. omni-range; (3) Gee; (4) the Decca Navigator. It was significant that the only one of these which did not use high radio frequencies was the Decca Navigator. For some time, B.E.A. had been carrying out an assessment of the Navigator, in conjunction with the Flight Log: no doubt a number of problems remained to be solved but, fundamentally, this line of development did seem to be the right one.

If the landing or take-off was made in a region with no fixed-wing airfield, and in particular a region not in a control zone, the problem was somewhat simplified. The pilot could approach very near to the landing site using the navigational aid, assumed to be the Decca Flight Log. Under V.F.R., the final landing was then visual, but in I.F.R. the pilot must first break cloud. He might possibly be heading for a landing site of 300ft diameter, with a cloud base about 300ft above ground level, and the speaker did not think that such an approach could be successfully completed on the Flight Log alone. The presentation might correspond to a map scale of two miles or more to the inch, and even if wider scales were made available, the pilot would find difficulty in controlling the aircraft while at the same time monitoring his ground position in conjunction with altitude. The helicopter must descend through cloud probably at a fairly steep angle, and the pilot was entitled to a guarantee that when he broke cloud he would be correctly lined up for final descent and landing.

This indicated the need for a landing aid, although such a provision entailed extra expense and in the practical case this had to be weighed against the benefits derived. Such an aid could be of the I.L.S. type, or some modification of G.C.A. The G.C.A. type would have the advantage of greater flexibility, but the disadvantage of requiring an operator.

Whatever the aid, the main difficulty was that of flying the aircraft blind at slow speed. Stability might be provided by automatic devices, but large power variations with speed would remain a fundamental characteristic at low speeds. If, then, the aircraft was descending through a large wind gradient, the pilot might have to contend with large changes of power and hence of rate of descent. The vertical speed indicator usually provided was subject to lag, and some means of overcoming this was most desirable. The altimeter was also subject to lag, and it might eventually prove necessary to use a radio altimeter, also giving rate of descent as a differential, for this phase.

The control of high-density civil air traffic was a complex business and also could be considered under two headings, those of *en route* control, and of entry into, and departure from, control zones.

A consideration of existing airways in the U.K., together with the tentative helicopter route network proposed by Mr. Masefield in his lecture to the Helicopter Association [*Flight*, November 14th, 1952] showed that many of these routes could fit in to an airways system, and trunk routes were already so covered. Extensive and complicated development of the route network in the future, however, would create much difficulty in conforming to an airways system. It was difficult, however, to avoid the conclusion that large transport helicopters should use airways in I.F.R. conditions if possible. The prospect of fast, jet aircraft and helicopters flying in the same air space, but under separate control, was hardly acceptable.

If the landing area was near, or on, a fixed-wing airfield, and in particular in a control zone, then the problem of the relation between helicopters and fixed-wing traffic became really serious. *En route*, the two types had been rather uneasy stable-mates—while the helicopter tended to make a nuisance of itself by flying rather slowly, it minimized interference by flying at lower altitudes. In control zones, however, all aircraft flew low, and the complexity of the problem was illustrated by consideration of the London control zone (diagram opposite). The existing complexity of the air traffic control techniques in the London zone would be increased with the addition of scheduled helicopter traffic, which would require freedom to land not only at Northolt and London Airport, but also at a site near the centre of London —for instance, Waterloo.

Considering the slow-speed characteristics of civil transport helicopters, it was probable that the minimum-power speed would rise from about 40 kt to 80-100 kt in the future, and in order to hover at maximum weight, high percentage power would be required—with correspondingly high fuel consumption. A pilot would be reluctant to fly at zero speed unless it was absolutely essential, and in control zones he would prefer not to cruise appreciably below his minimum-power speed. This indicated that control techniques should not be based on the assumption that the helicopter could be told to hover over a pin-point, but on the assumption of a cruising speed of about 80 to 100 kt.

During B.E.A. helicopter operations into the London control zone, the general principle had been to give the helicopter special entry points and holding points, the machine finally entering London Airport at right angles to the duty runway. If the helicopter track intercepted a fixed-wing track, the helicopter had been expected to hold over a small area until the way ahead was clear. Using this technique, every intersection presented a timing problem to the controllers, and the pilot was likely to be faced with a good deal of low-speed flying—an unpopular flight regime.

An alternative was that helicopters entered from the airways as did fixed-wing aircraft. Entering and out-going aircraft had a height separation and the helicopter adhered to the fixed-wing pattern until it finally broke away towards its separate landing site. This seemed to be the better method.

The problem of outgoing helicopters remained; high-density operations from the hypothetical Waterloo site in addition to Northolt and L.A.P. would call for extremely careful co-ordination. Indeed, the present system might break down and the solution might be in the use of a navigational aid permitting smaller horizontal separation.

In conclusion, Mr. Davies emphasized that the term "navigation" had been interpreted fairly widely in his paper to include some operational problems, for the two were in some cases hardly separable. Inevitably, consideration of such problems at this stage must be speculative.

A MAJOR LEAKAGE

IT is reported by *Aviation Week* that a "complete catalogue of major weapons and ordnance being bought by the military Services, including many items classified under military security regulations, was released by the Defence Department in one of the biggest leaks in the military security system in recent years." Our contemporary states that the classified weapons were listed in an appendage to an unclassified directive on production records and monthly acceptance reports, signed by Roger Kyes, Deputy Secretary of Defence—who announced his resignation, effective on May 1st.

Among aircraft named in the procurement programme which have not previously been identified officially as production items are the Douglas A4D Navy carrier-based attack machine powered by a Wright J65; the Republic F-105, a fighter/bomber for the U.S.A.F., powered by an Allison J71; the Douglas C-133 heavy transport for the U.S.A.F., with Pratt and Whitney T34 turboprops; and the Convair TF-102 delta-wing supersonic trainer, with a Pratt and Whitney J57.

Also listed are eighteen guided missiles for the U.S.A.F., Navy and Army. These are categorized as follows: *Surface-to-air:* Douglas Nike I. XSAM-A-7, Army; Bendix Talos XSAM-N-6 and Talos W, XSAM-N-6, Navy; Convair Terrier I XSAM-N-7, Navy. *Surface-to-surface:* Firestone Corporal XSSM-A-17, Army; Martin Matador B-61, U.S.A.F.; Chance Vought Regulus XSSM-N-8 and XSSM-N-8A, Navy; Northrop Snark B-62, U.S.A.F. *Air-to-surface:* Dove XASM-N-4, Navy; Fairchild Petrel XAUM-N-2, Navy; Bell Rascal B-63, U.S.A.F.; Martin Gorgon 5 XASM-N-5, Navy. *Air-to-air:* Hughes Falcon F-98, U.S.A.F.; Sparrow I XAAM-N-2, Navy; Sparrow 2 XAAM-N-3, Navy; Sparrow 3 XAAM-N-6, Navy; Martin Oriole XAAM-N-4, Navy; Sidewinder XAAM-N-7, Navy.

Other missile equipment listed includes dual-type shipboard and ground launchers for the Terrier; ground-launching and handling equipment for Nike batteries; Nike missile assembly-area equipment; Corporal ground-launching and handling equipment; and Corporal assembly-area equipment. Particulars are given of the Army's Honest John and Loki rocket missiles. Honest John is described as a 762-mm artillery rocket, and Loki as a 76-mm anti-aircraft rocket.

Among radar and radio equipment the following items appear: Mortar-locating radar APN/TPQ-5; ground-guidance systems for Corporal and Nike missiles; control monitor group for Petrel, AN/APA-80; tracking and guidance radar for Terrier, AN/SPQ-5; ground fire-control system for Terrier, AN/MSG-3; airborne anti-submarine radar, AN/APS-44; airborne radar countermeasure set, AN/APT-6 and -16; airborne search, bombing and navigation radar, AN/APS-31 and -33; airborne ground-position indicator for a combat information centre, AN/APA-57; and radar countermeasures transmitting set, AN/ALT-3 and -5.

SAFIR AT SYDNEY

A SAAB Safir 91C four-seater trainer/tourer is to be shown at the Swedish Exhibition, which will open on June 16th at Sydney's largest department store, David Jones, Ltd. It will be the first series-manufactured machine of the modified type now being built under sub-contract by the de Schelde concern in Holland. Top speed is 170 m.p.h., cruising speed 150 m.p.h., and normal range 560 miles. Some 200 Safirs of earlier versions have so far been delivered. The latest—and fourth—air force to acquire Safirs is that of Indonesia.

THE B.E.2 SERIES (PART II)

Historic Military Aircraft No. 7

By J. M. BRUCE, M.A.

THIS is the second instalment of Mr. Bruce's article on this famous—or, as many who flew them would say, notorious—series of machines designed by the Royal Aircraft Factory. Part I was published in our issue of April 2nd.

THE B.E.2C was used by both the R.F.C. and the R.N.A.S., and on almost every front. The first to go to France was the solitary specimen taken over by the Aircraft Park, and by March 10th, 1915, there were still only thirteen B.E.2Cs with the R.F.C. squadrons in the field. By the late summer of 1915, large numbers of B.E.s were being turned out, and 74 were on the strength of the R.F.C. in France on September 25th, 1915. In the early months of the war the equipment of most R.F.C. squadrons consisted of a mixture of several types of aeroplane, and it was not until April 15th, 1915, that the first squadron—No. 8—wholly equipped with B.E.2Cs arrived in France.

The B.E.2C fared no worse than any other type up to the autumn of 1915, and carried out its duties of bombing and reconnaissance without much trouble. Throughout the summer of 1915, however, fighting in the air became an increasingly frequent feature of the war, and in this respect the B.E.2C was soon outclassed. When the Fokker monoplanes with their synchronized Spandau machine-guns began their depredations towards the end of the Battle of Loos, the B.E.'s fate was sealed. Immelmann's victory log almost amounts to a catalogue of destroyed B.E.s: of the sixteen Allied machines shot down by him before the Battle of the Somme, at least six (and possibly nine) were B.E.s.

In combat, the B.E.2C was well-nigh defenceless and helpless. The observer occupied the front seat, and could fire a gun effectively only in a rearward direction. Normally, the observer was the gunner, and had a single Lewis gun for which several sockets were provided, on either side of and behind his cockpit. In combat he was obliged to move the gun from mounting to mounting, an undertaking which drew this comment from a B.E.2C pilot of 1915: "... swinging that gun around from mounting to mounting, hanging on whilst I did the wildest of turns, keeping a cool head in an emergency, demanded from the observer the qualities of an acrobat, a strong man, and a juggler."*

There was no British interrupter or synchronizing gear available, and if the pilot wanted to do any shooting he usually had to content himself with a Lewis gun mounted on the side of the fuselage, pointing outwards at an angle so that the bullets missed the airscrew. This mounting was devised in the summer of 1915, by Capt. L. A. Strange, then of No. 12 Squadron. To fire the gun the pilot had to fly crabwise, and it is almost superfluous to add that accuracy was not of a high order. Various arrangements of assorted weapons were fitted to the B.E.2C in makeshift fashion and in efforts to provide effective defensive armament. One machine of No. 4 Squadron carried as many as four Lewis guns; on the other hand, several crews discarded even the more usual single Lewis, preferring the slightly increased performance of the unarmed B.E. to an ineffective weapon. A far more desperate device was that fitted to his B.E.2C by an officer of No. 6 Squadron. It consisted of a lead weight lowered on a steel cable from a small winch in the cockpit: with it he attempted to manœuvre above his enemy and entangle the cable in the German machine's airscrew. Fortunately for himself he never succeeded in his object.

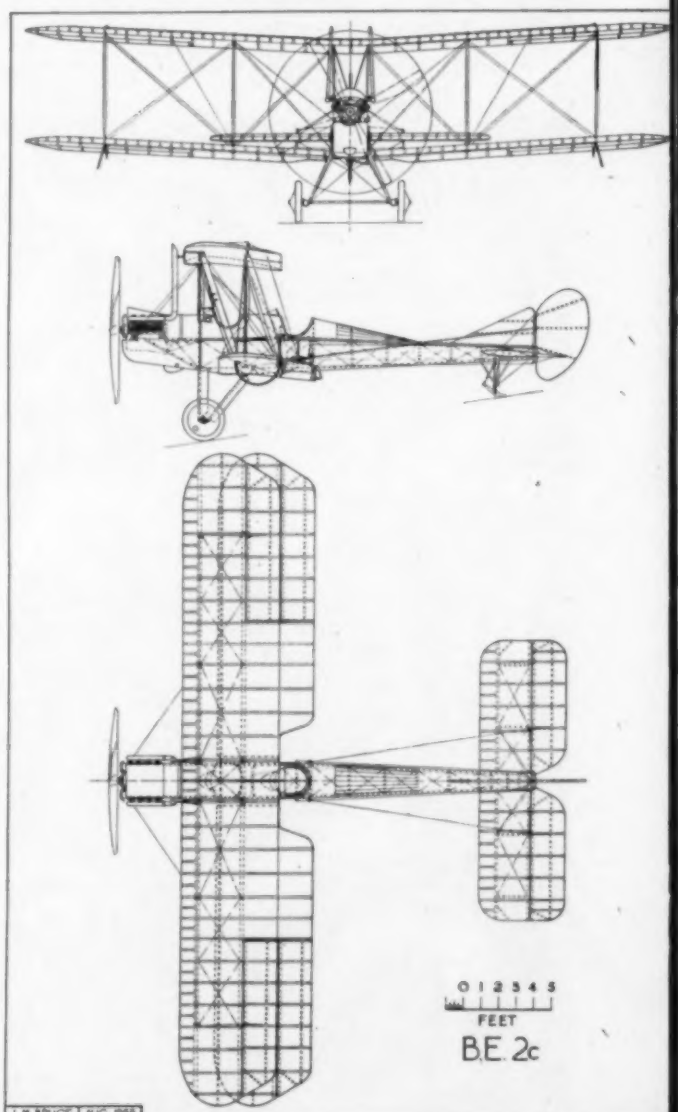
Apart from difficulties with armament, the B.E.2's inherent stability proved to be a disadvantage, for it deprived the aircraft of the manœuvrability so vital in combat. By the end of 1915, the B.E.s were forming an alarmingly large proportion of the "Fokker fodder" of the time, but no attempt was made to modify or withdraw the machine, or even to suspend production. Attention was dramatically focused on R.F.C. casualties by Mr. Noel Pemberton-Billing, who, in a bitter speech in the House of Commons on March 21st, 1916, attacked Factory machines in general and the B.E.2C in particular, saying that R.F.C. pilots in France had been "rather murdered than killed."

A judicial committee was set up to investigate these charges, but did not deliver itself of its findings until December 1916. In general, the charges were found to be not proven, and in the meantime the B.E.s plodded on: bombing, observing, and trying to fight, always with considerable losses.

As a bomber, the type was frequently flown as a single-seater, when two 112-lb bombs or one 112-pounder and four 20-pounders could be carried. Many R.N.A.S. B.E.2Cs had a bomb rack fitted externally directly under the engine, and some had the front seat faired over completely. Two B.E.2Cs of No. 4 Squadron, R.F.C., made the first British night raid of the war on the night of 19th/20th February, 1916. They were flown solo by Capt. E. D. Horsfall and J. E. Tennant, and their objective was Cambrai Aerodrome.

In other war areas, particularly where there was little or no aerial opposition, the B.E.2C gave good service. In the tropical heat of German East Africa, No. 26 Sqn. performed many valuable reconnaissance flights, particularly those by Capt. G. W. Hodgkinson and Lt. L. Walmsley, who took extra tins of petrol with them to top up their tanks in flight. By this means the B.E.'s endurance was increased to five hours. It is of interest to note that two of the B.E.2Cs used by this squadron were of R.N.A.S. type, and retained their original serial numbers. One such was No. 8424.

In the north of the African continent, Nos. 14 and 17 Sqns. flew B.E.s on operations in Egypt, and the type served in Palestine with No. 14 and No. 67 (Australian). The great heat pre-



* *From "Wind in the Wires," by D. Grinnell-Milne.*

A page from
THE ESSO HISTOIRE OF AERIAL LOCOMOTION
Adapted from the French de P. Crochet-Damais. Illustrated par Philippe Féty avec permission.

LEONARDO DA VINCI'S FLYING MACHINE

IT took man three centuries to rediscover, after Leonardo da Vinci, the principles of the screw, the parachute, the submarine, the motor car and the torpedo. It would take a little longer to explain some of the other fantastic devices with which the great Renaissance engineer, artist and boffin filled his copybooks. Crammed with scribbled notes and mysterious sketches, they contain diagrams of gliders, flapping wings, gremlins, and helicopters with great helical screws. Leonardo was the first to study the flight of birds with a view to mechanical imitation. Simultaneously he was painting a lady called Mona Lisa, whose long-suffering smile may well have been due to the artist's habit of flinging down his palette and dashing to the window to observe the behaviour of sparrows' wings under load.

His parachute, another novelty, was a stiffened linen tent underslung with leather and cords. Records suggest that it didn't handle any too well and it is impossible to tell from Mona Lisa's expression whether she hoped it would open or not.

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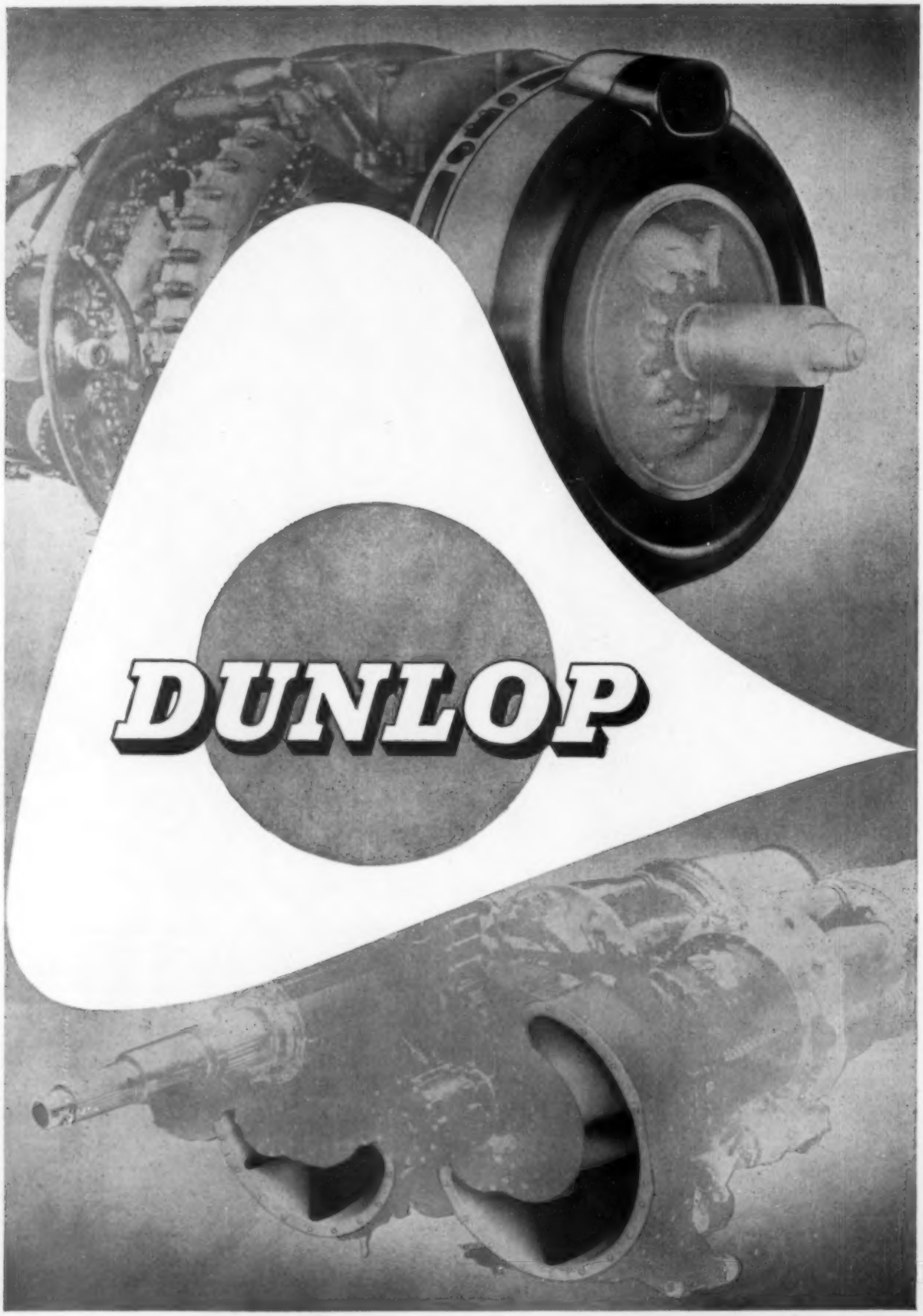
DUNLOP

ELECTRICALLY-HEATED RUBBER MATS PREVENT ICE FORMING

New Thermal Anticing System by Dunlop

Latest development by Dunlop in the important field of ice-prevention in aircraft is a thermal anticing system on the electric blanket principle. Suitable for all operating conditions the system consists of electrical heater circuits sandwiched between layers of synthetic rubber.

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The sandwiched circuits, tailored to fit individual applications, are attached directly to metal surfaces without impairing aerodynamic efficiency. They are designed to work off the aircraft's normal electrical system. Wattage can be varied as necessary.

Can be automatic

The circuit can be heated continuously or in cycles—or in a combination of both—by means of a controller. With an ice detector, the installation becomes fully automatic.

Many applications

In addition to jet engine intakes, shown on the opposite page, this system of protection is suitable for cabin heater intakes, air intakes, radio antennae, spinners and shutters.

THE HEAT IN THE SANDWICH

How the Thermal Mats are constructed

Above is an illustration of an intake with the top layer of rubber removed to expose the heater element.

An electrical circuit in nickel alloy is cut from metal strip less than ·010" thick. It is applied to the metal intake between layers of unvulcanised heat resisting chloroprene. Finally the entire assembly is subjected to heat and pressure to embed the circuit securely between the plies and cure the rubber compounds.

This curing or vulcanising process produces the required weather resistance and other physical properties necessary to ensure the efficiency of the system.

DUNLOP RAMS OPEN THE EYES OF REHEAT JETS

Designed to operate the 'eyelids' of jet re-heat nozzles, these Dunlop rams operate at temperatures exceeding the melting point of tin at 250°C. Actuation is controlled by a simple two-position solenoid operated valve. High temperature air filters and pressure reducing valves have also been developed for use with these rams.

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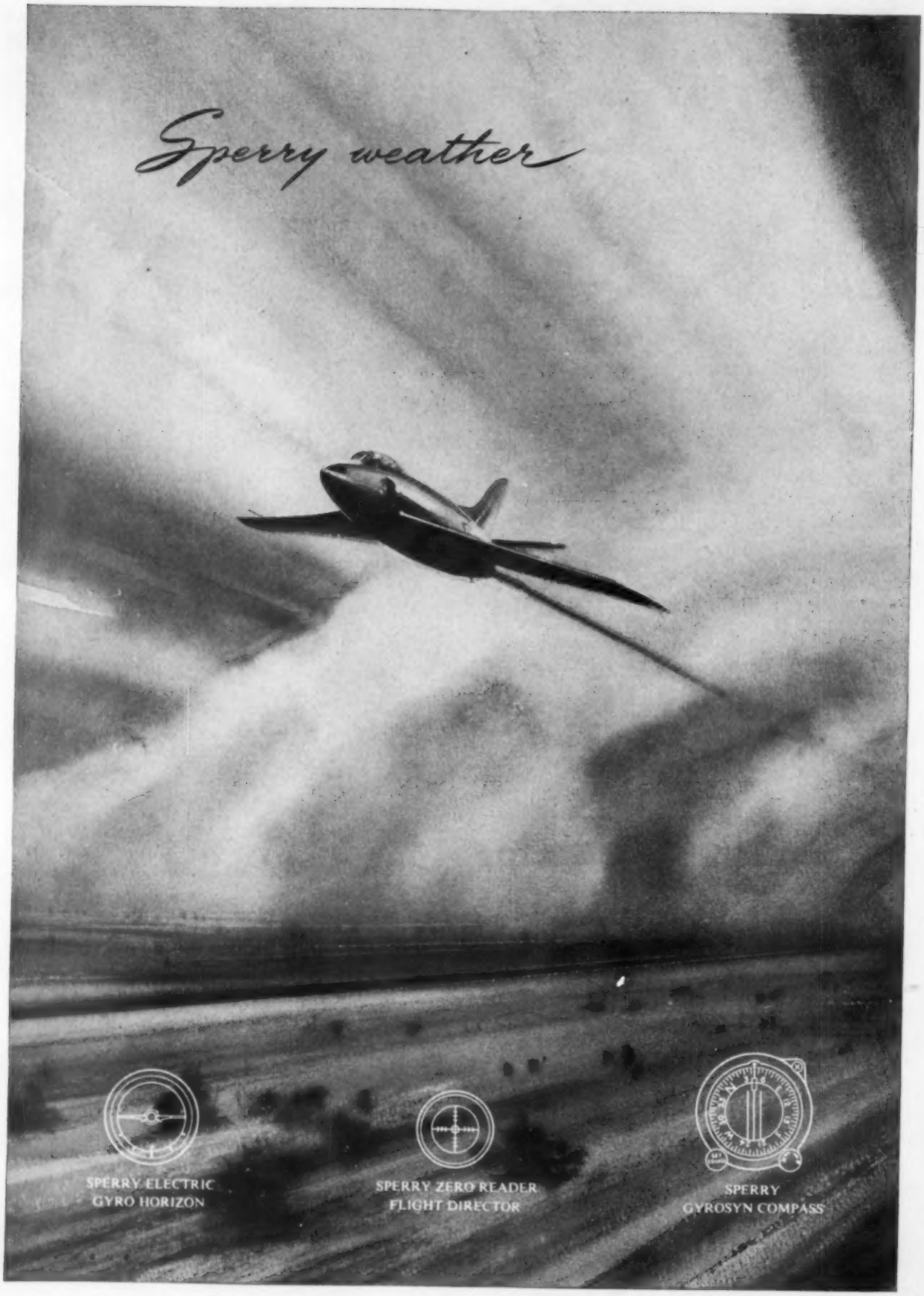
Sperry weather
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GYROSYN COMPASS

THE B.E.2 SERIES . . .

vented the machines from climbing higher than 5,000ft, at which altitude they were good targets for enemy aircraft and anti-aircraft gunners. On March 20th, 1917, Lt. F. H. McNamara of No. 67 (Australian) Squadron won the first V.C. to be awarded to a flying officer in the Middle East. Although wounded in the leg, he landed his Martinsyde Elephant in enemy territory to pick up Capt. Rutherford of his squadron, who had been forced down with engine trouble. McNamara's wound caused him to crash his Martinsyde when he attempted to take off with Rutherford on board, but the two officers came back in Rutherford's B.E.2C, flown by McNamara, in face of advancing Turkish cavalry, and faulty engine notwithstanding.

The B.E.2Cs of No. 30 Squadron dropped food on besieged Kut during the campaign in Mesopotamia: the load for each B.E. consisted of a 50-lb bag on each lower wing-root, and two 25-lb bags between the undercarriage struts. Thus loaded, the machines were tricky to fly, and were at a greater disadvantage than ever when attacked by enemy aircraft. No. 30's B.E.s carried out many useful bombing attacks during the campaign. One of the squadron's machines was the veteran B.E.2C No. 4500. Built by G. and J. Weir, Ltd., No. 4500 had first seen action in 1915 in the Battle of Ctesiphon; she had been flown out of Kut when the siege began, and thereafter gave faithful service in Mesopotamia until her career was ended on April 15th, 1917, in a hopelessly unequal combat with a Halberstadt scout.

B.E.2C with 90 h.p. Curtiss OX-5 engine.

B.E.2D.

B.E.2E.

In July 1916, No. 17 Squadron took its B.E.s to Macedonia, where they were used mainly for reconnaissance duties. In the Eastern Mediterranean the type was also flown by No. 2 and No. 3 Wings of the R.N.A.S. No. 3 Wing arrived at Tenedos on March 24th, 1915, but the two B.E.2Cs which were among its equipment did not reach the island until the first week of April. They were not popular, and of them W/C. Samson wrote: "they were 'improved' B.E.2s; but we soon found that they were not half so good; in fact, they wouldn't take up a passenger with any comfort."

At that early date, these B.E.2Cs would almost certainly have been Renault-powered: the six which No. 2 Wing brought with it at the end of August 1915, all had Renault engines. This R.N.A.S. unit was still flying some R.A.F.-powered (i.e., with Royal Aircraft Factory engines) B.E.2Cs from Mudros in 1917.

Unrest along the North-West Frontier of India led to the formation of a R.F.C. unit known as "A" Flight of No. 31 Sqn., which left England for India with five B.E.2Cs at the end of November 1915, and arrived there on December 26th. "B" and "C" Flights followed in February and May 1916, and from Risalpur the squadron operated on the Mohmand border late in the year. Other effective operations were carried out against the Mahsuds in 1917 by detachments of No. 31 Sqn. In September 1917, No. 114 was formed at Lahore from a nucleus provided by No. 31.

It was in the field of Home Defence that the B.E.2C scored its real successes. Of the 17 enemy airships brought down in aerial combat by British forces during the war, no fewer than five were shot down by B.E.2Cs. One of these raiders was the wooden-framed Schütte-Lanz S.L.11,* destroyed on September 3rd, 1916, by Lt. W. Leefe-Robinson of No. 39 Sqn., who was awarded the V.C. for his action. For long the B.E. was the standard Home Defence machine, and was widely used by both R.F.C. and R.N.A.S. with greatly varying armament. In this particular duty its stability proved to be an asset, for it greatly simplified night flying, and made the machine a steady gun-platform when the target was attacked.

Some of the Home Defence B.E.s were armed with canisters of Ranken explosive darts, others carried bombs, and experiments were also carried out with Le Prieur rockets. But the most effective weapon against Zeppelins proved to be the Lewis gun, in which Buckingham incendiary, Brock explosive, and Pomeroy (P.S.A.) explosive ammunition was used.

The British and Colonial Aeroplane Co. supplied ten single-seat B.E.2Cs specially modified for Home Defence duties. These machines had an extra fuel tank, fitted in the space normally occupied by the front seat, to give them extended cruising endurance for anti-Zeppelin work. Leefe-Robinson was flying a Bristol-built B.E.2C when he shot down the S.L.11, and another, No. 4112, was flown by 2nd Lt. F. Sowery on September 24th, 1916, when he shot down the Zeppelin L.32 over Billericay.

With the introduction of the Gothas in 1917, the days of the B.E. as a Home Defence machine were numbered, for it lacked the performance necessary to intercept the bombers. It was gradually replaced by more effective aircraft.

The B.E.2C was still on active service in 1918, carrying out anti-submarine patrols over the watery desolation of the North Sea in company with D.H.6s. These machines seldom carried any armament apart from their bombs, and must have been looked upon as easy victims by the enemy pilots of "Flanders I": the B.E.s and D.H.6s would certainly have been no match for the Brandenburg KDW, W.12 and W.29 seaplane fighters flown by the Zeebrugge pilots.

To continue the thread of design development it is necessary to revert to 1915, when the B.E.2D appeared. This was a dual-control version of the B.E.2C, but could be distinguished by its external gravity fuel tank mounted under the port upper main-plane. The forward cockpit was modified in shape, and was cut rather lower at the sides. The B.E.2D was produced in substantial numbers by the British and Colonial Aeroplane Co., and by Ruston, Proctor and Co. Twenty-nine B.E.2Ds were in service with R.F.C. squadrons in France on July 1st, 1916.

Up to this time, B.E.2Cs and Ds alike had retained the original triangular fin, but in 1916 another development of the basic design appeared. This was the B.E.2E, characterized by single-bay wings of unequal span, with raked-back wing-tips and enormous extensions on the upper wing; a redesigned tail-plane with raked tips; and an enlarged fin with rounded leading-edge. The larger fin was thereupon standardized for B.Es: late production B.E.2Cs and 2Ds were fitted with it, and some also had the revised tailplane. Many 2Es had yet another form of

* It is interesting to recall that the wire-braced wooden structure of this airship was of geodetic design.—Ed.

THE B.E.2 SERIES

exhaust. This was a manifold of saxophone shape, the raked-back outlet being at the forward end. This form of exhaust was also used on some Armstrong Whitworth F.K.3s and D.H.6s.

More B.E.2Es were built than any other type of the B.E.2 series: current contracts were amended so that machines ordered as B.E.2Cs or 2Ds emerged as 2Es.

But in action the B.E.2E was no more successful than the earlier variants had been. The observer still occupied the front seat, and no effective form of defensive armament had been devised. Furthermore, the machine was not popular with its pilots, for it had a reputation for structural weakness. Rumours that any strenuous manœuvring would cause the extensions to collapse undermined crews' confidence, and performance was no better than that of the B.E.2C. If anything, therefore, the B.E.2E was even more helpless in combat than its predecessors had been.

The first B.E.2E in France was probably the one which was on the strength of No. 21 Sqn. on July 1st, 1916; and the first squadron to go to France completely equipped with the type was No. 34, which arrived at its aerodrome at Allonville on July 15th, 1916. The B.E.2E was used on Home Defence duties, and in Palestine, Mesopotamia, Macedonia, and India, but without distinction. In France it outlived the B.E.2C and 2D and, at the beginning of the Battle of Ypres (July 31st, 1917) was still in service with squadrons No. 8, 12 and 100, and with the Special Duty Flight of the Ninth (H.Q.) Wing. The Americans bought twelve B.E.2Es for use as trainers in England, and some were among the 251 assorted aeroplanes supplied to Russia in 1916 and 1917.

The B.E.2C, 2D and 2E were all normally powered by the 90 h.p. R.A.F.1a engine, but several other types of engine were fitted at various times. Some B.Es had the 105 h.p. R.A.F.1b, a development of the R.A.F.1a which had cylinders of slightly larger bore: a few machines had the R.A.F.1d, which had aluminium cylinders with deep fins and overhead inlet and exhaust valves.

Some 17 B.E.2Cs had the 90 h.p. Curtiss OX-5 engine; at least three B.E.2s had the 75 h.p. Rolls-Royce Hawk; and some installations of the 150 h.p. Hispano-Suiza were made. The first official installation of a Hispano-Suiza was carried out at Farnborough, the airframe being that of B.E.2C No. 2599, but it is believed that an earlier and unofficial installation in a B.E.2C was made in France, in the workshops at St. Omer early in 1916. Done at the suggestion of Maj. A. Huggins, who was at that time the C.O. of No. 1 Aircraft Depot at St. Omer, this was probably a "home-made" attempt to improve the B.E.'s poor performance.

B.E.9 "Pulpit."

B.E.12 prototype.

The Belgian Flying Corps also modified a number of its B.E.2Cs to take the 150 h.p. Hispano-Suiza engine and, while they were about it, transposed the pilot's and observer's seats, thus giving the latter a better field of fire. The officer chiefly responsible for the execution of these modifications to the Belgian B.Es was Armand Glibert, a member of the 6th Belgian Squadron, which unit was equipped with B.E.2Cs. But even the additional power of the Hispano produced no worthwhile improvement in the B.E.'s performance, for the service ceiling was no better than 11,000ft. Glibert fell a victim to the machine's shortcomings: on April 8th, 1917, he and his observer, Lt. Callant, were returning in a Hispano-B.E. from a reconnaissance of Bruges when they were shot down and killed.

At home, a few B.E.2Es were also fitted with Hispano-Suiza engines.

In response to demands from the squadrons in France, a few B.E.2Cs were equipped with armour plate around the engine and cockpits, and it is believed that No. 15 Sqn. had some of these machines at one time. No doubt they provided some data for (and may to some extent have inspired) the layout of the A.E.2, an armoured tractor biplane designed at Farnborough in 1917.

Many developments were made from the basic design, by far the most remarkable being the B.E.9 of 1915. This weird machine was constructed by drastically modifying the Bristol-built B.E.2C airframe No. 1700, and represented a misguidedly determined attempt to provide forward-firing armament on a tractor machine. This was, of course, before the advent of interrupter gears. The engine was moved back under the centre section, and a nacelle for the observer/gunner was suspended on the forward end of the airscrew shaft: bracing struts supported the nacelle from the undercarriage. (It is of considerable interest to recall that an identical layout was adopted in the French SPAD types A.2, A.4, A.5 and D of 1915. The first two prototypes crashed ignominiously and fatally at Avord, but some production was undertaken, for at least one example—probably an A.4—was used by the Russians. Nor did Farnborough abandon the basic conception, for the projected F.E.10 single-seat fighter was designed to have the pilot's cockpit mounted in front of the airscrew.)

The B.E.9 was usually referred to as the "Pulpit B.E.2C," and underwent service trials in France with No. 16 Squadron in the autumn of 1916. Of it, one ex-R.F.C. officer wrote:—"... Major Brooke-Popham ... lives in my memory because he went up in a horrible contraption called the Pulpit B.E.2C, and refused to condemn it. In response to a growing complaint from B.E. pilots and observers that they were being shot down wholesale, and could do little to defend themselves owing to the cock-eyed position of the observer, some genius built a seat on to the front of the B.E., staying it from the undercarriage and wings. There the observer was supposed to sit, with his head a foot in front of the propeller. He had an excellent field of fire for his gun, and an excellent field of vision. Usually, too, he had an excellent attack of vertigo, from fright, every time the machine took off and landed."*

Duncan Grinnell-Milne, who served in No. 16 Squadron for a time, wrote of the B.E.9 in similar terms in his *Wind in the Wires*, and concluded: "... even in 1915, when almost every new machine was looked at with delighted wonder, it was recognized that in the B.E.9 unsuitability of design had reached its acme. The 'Pulpit' was soon returned to the depot."

No B.E.10s were actually built, but the type was designed as a development of the B.E.2C. It was to have been of part-metal construction, and was to have had full-span ailerons-cum-flaps similar to those of the S.E.4: the aerofoil section of the wings had a reflex trailing-edge. Four, numbered 1648 to 1651, were ordered from the British and Colonial Aeroplane Co. in 1914, and the steel tube construction of the fuselage earned the B.E.10 the nickname of "the gas-pipe aeroplane" at the Bristol works. The B.E.10s were abandoned in favour of the B.E.2C after only a little work had been done towards their construction.

Another Bristol-built B.E.2C, No. 1697, became the prototype B.E.12. This was an attempt to make the B.E. into a single-seat fighter, powered by the 140 h.p. R.A.F.4a vee-twelve engine, and was followed by the B.E.12A, which was a similar modification of the B.E.2E airfame. But their history is another story.

B.E.s of various kinds were widely used for experimental purposes, but none was more usefully employed than the B.E.2C on which the first Constantinesco gun synchronizing gear was tested in August 1916. Some of the credit for this invaluable device is due to Major C. C. Colley of the Royal Field Artillery, who first suggested the application, in the form of a synchronizing gear, of M. George Constantinesco's theory of wave transmission; and to Major Bertram Hopkinson, who, on his own responsibility, gave Constantinesco an order for twelve gears, worth £600, and thereby provided the Rumanian inventor with

* *From "Flying and Soldiering," by R. R. Money.*

the capital necessary for the development of his invention.

Perhaps the most remarkable experiment in which a B.E.2C participated was that conducted at Kingsnorth airship station in an endeavour to provide an anti-Zeppelin aircraft of great endurance. A complete B.E.2C was attached to an S.S.-type airship envelope, the intention being that the aerostat should support the aeroplane until the enemy was sighted, whereupon the airship envelope would be released, and the B.E. would proceed to the attack in the normal way. The inventors of this airship-plane, as the aircraft was called, were Cdr. N. F. Usborne and Lt-Cdr. de Courcy W. P. Ireland.

The first trials, in August, 1915, were made by Flt. Cdr. W. C. Hicks, but the controlling gear left a good deal to be desired, and it was not until February 21st, 1916, that the composite craft's first true trial flight was made by Usborne and Ireland. The experiment failed tragically, for at about 4,000 ft the envelope and aeroplane separated prematurely: the B.E. fell away and turned over, throwing out Ireland, then crashed, out of control, in the goods yard of Strood railway station. Usborne was killed in the crash. He had been a close friend of E. T. Busk, the designer of the B.E.2C.

For various aerodynamic experiments B.E.2Cs, 2Ds and 2Es were used, and some idea of the variety of these experiments may be gained from the notes on individual machines which are appended. Special mention must be made of 4122, which was used early in 1918 in some of the first experiments with variable-pitch airscrews. Aerofoils of R.A.F.14, 15, 17, and 18 sections were tested exhaustively, and one of the experimental B.E.2Es had wings of 6ft 1in chord and 399 sq ft area: the corresponding standard dimensions were 5ft 6in and 360 sq ft. In 1917, a B.E.2E was used by Dr. F. A. Lindemann (now Lord Cherwell) in the first scientific investigations into the behaviour of an aeroplane in a spin, and his courageous researches provided much-needed information on a phenomenon which up to that time had not been understood at all. A B.E.2C with pronounced backstagger was still at the R.A.E. in June 1920, doubtless the subject of further experiments.

Very few B.E.s came on to the British Civil Register after the war. Only one B.E.2C and eleven B.E.2Es received such registrations. In Australia, A B.E.2E (C.6986, registered G-AUBF) was one of the first machines used by the Queensland and Northern Territory Aerial Service Co., Ltd., in 1921.

As we have shown, the history of the B.E.s was not a happy one; for long they were the objects of acrimonious publicity and bitter debate at home, and of the persistent and unwelcome attentions of enemy fighter pilots in France. It is a tale shot through with unequal combats and dreadful losses, relieved only by the surpassing courage of the men who daily flew to war in the full knowledge that theirs was an aircraft in every vital way inferior to those enemy machines they must encounter.

There can be no doubt that the B.E. design will go down in our aircraft history as the supreme and most horrible example of the State-designed aeroplane in all its standardized inferiority. Its shortcomings were summed up with splendid simplicity by Capt. Albert Ball, V.C., D.S.O., M.C., who flew B.E.2Cs and 2Ds for many hours with Nos. 13 and 8 Sqns.: "They were not for fighting," he said. But most pilots of the period would probably be quicker to endorse Ball's far more spontaneously pungent reply to General H. M. Trenchard, when asked for his opinion of a B.E. he had just tested. The feelings of all B.E. pilots were in his exclamation: "It's a bloody awful machine."

B.E.2 SERIES DATA

Power Plants.—*B.E.1:* 60 h.p. Wolseley, later 60 h.p. Renault. *B.E.2, 2A, 2B:* 70 h.p. Renault; 60 h.p. E.N.V. (experimental). *B.E.2C:* 70 h.p. Renault; 90 h.p. R.A.F.1a; 105 h.p. R.A.F.1b; 105 h.p. R.A.F.1d; 90 h.p. Curtiss OX-5; 150 h.p. Hispano-Suiza. *B.E.2D:* 90 h.p. R.A.F.1a. *B.E.2E:* 90 h.p. R.A.F.1a; 105 h.p. R.A.F.1b; 150 h.p. Hispano-Suiza; 75 h.p. Rolls-Royce Hawk.

Manufacturers.—The Royal Aircraft Factory, Farnborough, built one B.E.1 in 1912, one B.E.2 in 1912, and 5 B.E.2s in 1913.

Other Contractors.—*B.E.2, 2A, 2B:* Sir W. G. Armstrong Whitworth and Co., Ltd., Gosforth, Newcastle-on-Tyne; British and Colonial Aeroplane Co., Ltd., Filton, Bristol (built 19 B.E.2As, 6 B.E.2Bs); Coventry Ordnance Works, Ltd., Coventry; Handley Page, Ltd., Cricklewood, London: Hewlett and Blondeau, Ltd.; Clapham Works; Vickers, Ltd. (Aviation Dept.).

B.E.2C, 2D and 2E: Sir W. G. Armstrong Whitworth and Co., Ltd.; Austin Motor Co., Ltd., Northfield, Birmingham; Barclay, Curle and Co., Ltd., built B.E.2Cs and 2Es, A.1261-A.1310, and B.E.2Es C.7001-C.7100; Blackburn Aeroplane and Motor Co., Ltd., Leeds, built B.E.2Cs 964-975, 1123-1126, 1128-1146, 3999 and 9951-10000; William Beardmore and Co., Ltd., Dalmuir, built B.E.2Cs 1099-1122, 8326-8337, 8488-8500, 8606-8629 and 8714-8724. British Caudron Co., Ltd., Broadway, Cricklewood, built B.E.2Cs numbered B.6151-B.6200. British and Colonial Aeroplane Co., Ltd., built B.E.2Cs numbered 1652-1697, 1698-1747, 4070-4219 and 4700-4709, B.E.2Ds 5730-5879, B.E.2Ds and 2Es 7058-7257, B.E.2Es A.2733-A.2982, A.8626-A.8725 and B.4401-B.4600. A contract for a further 50 B.E.2Es, numbered C.1701-C.1750, was cancelled.

Coventry Ordnance Works, Ltd., Daimler Co., Ltd., and William Denny Bros., Dumbarton, built B.E.2Cs and 2Es A.1361-A.1410, B.E.2Es C.6901-C.7100. Eastbourne Aviation Co., Ltd., Eastbourne, built B.E.2Cs 1183-1188 and 8404-8433; Grahame White Aviation Co., Ltd., Hendon, built B.E.2Cs 1147-1170 and 8293-8304; Handley Page, Ltd., and Hewlett and Blondeau, Ltd., built B.E.2Cs 976-987 and 1189-1194.

Martinsyde, Ltd., Brooklands, Weybridge and Woking, built B.E.2Cs 988-999; Napier and Miller, Ltd., Old Kirkpatrick, built B.E.2Cs and 2Es A.1311-A.1360, B.E.2Es C.7101-C.7200.; Ruston, Proctor and Co., Ltd., Lincoln, built B.E.2Cs 2670-2769 and B.E.2Ds 6228-6327; Siddeley-Deasy Motor Car Co., Coventry, and Vickers, Ltd., built B.E.2Cs 952-963 and 1075-1098; Vulcan Motor Co., Southport, built B.E.2Ds and 2Es 6728-6827, B.E.2Cs A.1792-A.1891, and B.E.2Es B.3651-B.3750; G. and J. Weir, Ltd., Glasgow, built B.E.2Cs 4300-4599. Wolseley Motors, Ltd., Adderley Park, Birmingham, built B.E.2Cs and 2Es 2470-2569, and B.E.2Es A.3049-A.3148. *Australia:* One or two B.E.2Cs were built at Point Cook.

Production and Allocation.—Official statistics do not distinguish the variants, and show only a total of 1,793 aircraft of all four sub-types B.E.2A, 2B, 2C and 2D. No accurate figures for the B.E.2 and B.E.2E are available.

TABLE I: DELIVERIES* FROM AUGUST, 1914, ONWARDS

Type	Training Units	Home Defence	Expeditionary Force	Middle East Brigade	Total
B.E.2	2	—	30	—	32
B.E.2A ...	7	—	7	1	15
B.E.2B... ...	64	1	19	1	85
B.E.2C ...	294	136	487	200	1,117
B.E.2D ...	54	1	136	—	191
B.E.2E ...	913	160	503	225	1,801

* To R.F.C. and R.A.F. only; R.N.A.S. not included.

On October 31st, 1918, only 474 B.E.2Cs, 2Ds and 2Es remained on charge to the R.A.F. Of these, only one was with the Expeditionary Force in France; 67 were in Egypt and Palestine; 6 were at Salonika; 6 were in Mesopotamia; 58 were on the N.W. Frontier of India; 4 were in the Mediterranean area; and 7 were *en route* to the Middle East. At home, 3 were at Aeroplane Repair Depots; 10 were in store; 21 were with Home Defence units; 6 were with Coastal Patrol units; 2 were at Aircraft Acceptance Parks; 4 were in Ireland with the 11th Group; and 279 were at schools and various other aerodromes.

Costs.—B.E.2C and 2E airframes, less engine, instruments and guns, £1,072 10s; R.A.F.1a engine, £522 10s; Renault, £522 10s; Curtiss OX-5, £693 10s.

TABLE II: DIMENSIONS

	B.E.2A	B.E.2C	B.E.2D	B.E.2E
Span	38ft 7½in	37ft	36ft 10in	30ft 6in*
Length	29ft 6½in	27ft 3in	27ft 3in	27ft 3in
Height	—	11ft 1½in	11ft	12ft
Chord	6ft 4in	5ft 6in	5ft 6in	5ft 6in
Gap	—	6ft 3.19in	—	6ft 3½in
Stagger	Nil	24in	24in	24in
Dihedral	—	3° 30′	3° 30′	3° 30′
Incidence	—	3° 30′†	4° 09′	4° 15′
Tailplane span ...	12ft	—	—	—
Wheel track	6ft 2in	5ft 9½in	5ft 9½in	5ft 9½in
Wing area	374 sq ft	371 sq ft	—	360 sq ft

* Upper wing 40ft 9in. † For R.A.F. 6; R.A.F. 14, 4° 09′.

TABLE III: WEIGHTS AND PERFORMANCE

	B.E.2A	B.E.2C (R.A.F.1a)	B.E.2E (R.A.F.1a)
Weight empty	1,274 lb	1,370 lb	1,431 lb
Military load	—	520 lb	430 lb
Fuel and oil	—	252 lb	229 lb
Weight loaded	1,600 lb	2,142 lb	2,090 lb
Max. speed (m.p.h.)			
at s.l.	70	95	97
at 6,500ft	65	72	82
at 10,000ft	—	69	75
Climb to 3,000ft ...	9 min	—	—
to 7,000ft	35 min	—	—
to 10,000ft	—	45 min	53 min
Service ceiling	10,000ft	10,000ft	11,000ft
Endurance	3 hours	3½ hours	3½ hours

Additional data.—B.E.1: max. speed 59 m.p.h.; climb to 600ft, 3 min 52 sec. B.E.2: weight loaded 1,650 lb. B.E.2C (Renault): max. speed 75 m.p.h.

Service Use.—**B.E.2, 2A, 2B:** R.F.C. Squadrons No. 2, 4, 6, 8, 9, 12 and 16; No. 3 Wing, R.N.A.S., Dunkirk, Tenedos and Mudros; R.N.A.S. Station, Great Yarmouth; *India*—Indian Flying School at Sitapur; *Australia*—Flying School at Point Cook (2 B.E.2As). *Training*—Various flying schools, including Gosport and Stirling.

B.E.2C: *Western Front.*—R.F.C. Sqadrons No. 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16 and 21; R.N.A.S., Dunkirk; No. 1 Wing, R.N.A.S.; 6th Squadron, Belgian Flying Corps, both R.A.F.1a and Hispano-Suiza versions.

Home Defence—H.D. Detachments of No. 19 Reserve Squadron, consisting of two machines at each of the following aerodromes: Hounslow, Wimbledon Common, Croydon, Farningham, Joyce Green, Hainault Farm, Suttons Farm, Chingford, Hendon and Northolt. These detachments became No. 39 Squadron on April 15th, 1916. Two B.E.2Cs at Brooklands, two at Farnborough, three at Cramlington. Three machines each to training squadrons at Norwich, Thetford, Doncaster

THE B.E.2 SERIES . . .

and Dover. Squadrons No. 33, 36, 39, 50, 51, 75, No. 5 Reserve Squadron. R.N.A.S., Great Yarmouth (and landing grounds at Bacton, Holt, Burgh Castle, Covehithe and Sedgeford), Redcar, Hornsea, Scarborough, Eastchurch.

South West Africa—South African Aviation Corps Unit. *East Africa*—No. 26 Squadron, R.F.C. *Egypt*—Squadrons No. 14 and 17. *Palestine*—No. 67 (Australian) Squadron. *Mesopotamia*—No. 30 Squadron. *Macedonia*—No. 17 Squadron. *India*—Squadrons No. 31 and 114. *Eastern Mediterranean*—No. 2 Wing, R.N.A.S., Imbros and Mudros; No. 3 Wing, R.N.A.S., Tenedos and Imbros.

Training—Used at various Training units, e.g. No. 26 Flying Training Squadron, Blandford; No. 44 at Waddington; No. 51 at Marham; No. 63 at Stirling; W/T. Telegraphists School, Chattis Hill; School of Photography, Map Reading and Reconnaissance, Farnborough; Air Observers' Schools at New Romney, Manston and Eastchurch; School of R.A.F. and Army Co-operation, Worthy Down; R.N.A.S., Cranwell; Belgian Flying School, Etampes; Australian Flying School, Point Cook.

B.E.2D: *Western Front.*—R.F.C. Squadrons No. 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 42, H.Q. Communication Squadron. *Training*—No. 63 Squadron, and mainly as for B.E.2C.

B.E.2E: R.F.C. Squadrons No. 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 21, 34, 42, 52, 53, 100, Special Duty Flight of Ninth (H.Q.) Wing, H.Q. Communication Squadron. *Eastern Front*—Used by Russian Flying Corps. *Home Defence*—Obviously distributed on a similar scale to the B.E.2C; Squadrons No. 51 and 78 known to have used the type. *Palestine*—Squadrons No. 14, 67 (Australian), 113, 142, "B" Flight formed from No. 23 Training Squadron, "X" Flight at 'Aqaba. *Mesopotamia*—No. 30 Squadron. *Macedonia*—No. 47 Squadron. *India*—Squadrons No. 31 and 114. *Training*—Training Squadrons No. 26 and 44; Chattis Hill, Farnborough, New Romney, Manston, Eastchurch and Worthy Down as detailed for B.E.2C; R.N.A.S., Cranwell 12 used by the Americans at Ford Junction; Australian Flying School, Point Cook.

Armament.—B.E.2, 2A, 2B: One 100-lb bomb or approximately equivalent load of smaller bombs, hand grenades, rifles, pistols and carbines were carried for defence.

B.E.2C: Bomb load varied considerably. Possible combinations were 3 × 25-lb French bombs (Renault-B.E.2C); 2 × 112-lb bombs (solo); one 112-lb and 4 × 20-lb bombs (solo); 10 × 20-lb bombs (solo). Bombs were carried in racks under the fuselage, under the inner bays of the lower wings, and, in the case of some R.N.A.S. B.E.s, in a special rack immediately under the engine. Defensive armament varied enormously, from nil to a total of four Lewis guns. Usual basic armament was one Lewis gun, for which brackets were provided in two, three or more positions between the cockpits: usually this gun, fired by the observer, could fire to the rear only.

Alternatively or additionally, the pilot had a fixed Lewis gun on a Strange-type oblique mounting, firing forwards and outwards to clear the airscrew. A few machines had a Lewis gun on a mounting behind the pilot's cockpit: this gun was fired by the pilot. Single-seat bomber B.E. pilots usually carried a rifle.

Home Defence B.E.s sometimes had a Lewis gun or pair of Lewis guns mounted between the cockpits and firing upwards over the trailing edge of the centre section: and some R.N.A.S. machines had a Lewis on a high bracket immediately in front of the cockpit and inclined slightly upwards so as to fire under the centre section and yet clear the airscrew. Other war loads of Home Defence B.E.s were 24 Ranken Darts plus 2 × 20-lb H.E. bombs plus 2 × 16-lb incendiary bombs; or 10 Le Prieur rockets.

B.E.2D and 2E.—Generally similar to the B.E.2C. Some 2Es had a horizontal rod between the rear centre section struts, and on it the observer's Lewis gun was mounted.

B.E.1—201 **B.E.2, 2A, 2B.**—46 and 47 built at R.A.F. to Admiralty order; 49 and 50 built by Hewlett and Blondeau for Admiralty (No. 50 flown by Cdr. C. R. Samson); 202; 205-B.E.2 rebuilt from Howard Wright biplane, had a 60 h.p. E.N.V. engine at one time, but reverted to 70 h.p. Renault, crashed 27.5.13; 206-B.E.2 used at R.A.F. for fabric tests; 217-B.E.2A; 218-B.E.2A of No. 2 Sqn., flown by Capt. Longcroft, Montrose-Portsmouth-Farnborough, 22.11.13; 220-No. 3 Sqn.; 222-No. 2 Sqn., crashed 15.5.14; 225; 241-B.E.2As (226 was Bristol-built and completed at R.A.F. 13.8.13; after exposure tests was tested to destruction on 23.4.14; used by No. 3 Sqn.); 228, 229, 232-Bristol-built; 233 and 235 were used by No. 2 Sqn.; 234 and 239 were used by No. 6 Sqn.; 240 had a wireless installation; 267-No. 2 Sqn.; 272, 273; 299-No. 4 Sqn.; 317, 318, 327, 328-No. 2 Sqn.; 329-No. 6 Sqn.; 330-336 were B.E.2As; 331-No. 2 Sqn., crashed at Northallerton 15.5.14; 332-No. 2 Sqn.; 340 and 347-B.E.2As; 348 B.E.2A (experiments with R.A.F. recording tautness meter: this machine was looped); 349, 368 and 372 were B.E.2As; 441, 442, 447, 449-B.E.2As of C.F.S.; 452-454 were Vickers-built; 453 crashed 10.3.14; 457 and 465-B.E.2As of C.F.S.; 466-B.E.2A; 468-487, B.E.2As/Bs; 475-B.E.2A of "C" Flight, C.F.S.; 487-B.E.2B captured by Germans; 601-B.E.2A with fins on upper wing and modified tail unit; 2884-B.E.2B.

B.E.2C, 2D, 2E. *Admiralty orders for B.E.2Cs (70 h.p. Renault) to end of 1914:* 952-963, built by Vickers, transferred to R.F.C.; 964-975, built by Blackburn; 968 and 969 transferred to South African Aviation Corps, left U.K. 3.4.15, both damaged in trial flights after arrival in S.W. Africa; 976-987, built by Hewlett and Blondeau; 977 used by R.N.A.S., Great Yarmouth; 988-999, built by Martinsyde; 1075-1098, built by Vickers; 1099-1122, built by Beardmore; 1123-1126, built by Blackburn; 1128-1146, built by Blackburn; 1147-1170, built by Grahame White; 1183-1188, built by Eastbourne Aviation Co.; 1189-1194, built by Hewlett and Blondeau.

War Office Orders.—1652-1697 were B.E.2Cs (mostly 70 h.p. Renault), built by British and Colonial Aeroplane Co.; 1698-1747-B.E.2Cs (90 h.p. R.A.F.1a), built by British and Colonial; 1675 made forced landing on Dutch coast and was interned 1915; 1688 used for tests of R.A.F. low-altitude bomb sight 2.12.15; 1697 became prototype B.E.12; 1700 became B.E.9; 1730-B.E.2C "Manipur"; 1738 B.E.2C, 90 h.p. Curtiss OX-5; 1749 and 1783, B.E.2Cs; 1793-B.E.2C, R.A.F.1b engine, used for performance tests at R.A.F., summer 1916; 1799-B.E.2C; 2015-B.E.2C, R.A.F.1b engine, had pitot tubes suspended on a cross-bar mounted on a post immediately in front of fin.

B.E.2Cs-2017 (No. 13 Sqn.); 2026; 2034; 2037 (No. 16 Sqn.); 2043 (No. 13 Sqn.); 2045 (No. 13 Sqn.); 2049; 2092. Nos. 2470-2569 were B.E.2Cs and 2Es built by Wolseley; 2570-2669 were B.E.2Cs; 2599 had 150 h.p. Hispano-Suiza; 2670-2769 were B.E.2Cs built by Ruston, Proctor and Co.; 2737 used by "D" Flight, R.N.A.S., Cranwell; 3999-B.E.2C (70 h.p. Renault), built by Blackburn for Admiralty; 4070-4219 were B.E.2Cs built by British and Colonial; 4079-No. 13 Sqn.; 4084-No. 13 Sqn.; 4112-No. 39 Sqn., flown by Lt. F. Sowrey, shot down L.32; 4116-Immelmann's 13th victory; 4120, R.A.F.1d engine, tested with wings of R.A.F.19 section, June 1916; 4122, R.A.F.1a engine, used in experiments with v.p. airscrews, 1919; 4205, armoured: 4300-4599 were B.E.2Cs and Es built by Weir; 4312-B.E.2E, No. 67 Sqn.; 4362-B.E.2C, No. 3 Sqn.; 4426-B.E.2C, "D" Flight, R.N.A.S., Cranwell; 4700-4709-single-seat B.E.2Cs, built by British and Colonial; 5384-B.E.2C, built by Vickers; 5430 and 5431, B.E.2Cs; 5730-5879 were B.E.2Ds built by British and Co'onial; 5841-No. 13 Sqn., Richthofen's 32nd victory, 2.4.17; 6228-6327 were B.E.2Ds and 2Es built by Ruston, Proctor; 6232-No. 2 Sqn., Richthofen's 26th victory, 11.3.17; 6246-No. 63 Sqn.; 6304-B.E.2E: 6325 and 6326-B.E.2Es of "D" Flight, R.N.A.S., Cranwell; 6728-6827 were B.E.2Ds and 2Es built by Vulcan Motor Co.; 6808 was shot down on Russian front; 6742-No. 16 Sqn., Richthofen's 19th victory, 1.2.17; 7058-7257 were B.E.2Ds and 2Es built by British and Colonial.

Admiralty Orders, 1915-16 (all B.E.2Cs).—8293-8304 were built by Grahame White; 8326-8337 were built by Beardmore; 8404-8433 were built by Eastbourne Aviation Co.; 8423-"D" Flight, R.N.A.S., Cranwell; 8424-taken over by No. 26 Sqn., R.F.C., East Africa; 8488-8500 were built by Beardmore; 8606-8629 were built by Beardmore; 8623-"D" Flight, R.N.A.S., Cranwell; 8624, used as single-seater; 9456-9458 were B.E.2Cs fitted with Curtiss OX-5 engines; 9459-9461 were B.E.2Cs with R.A.F. engines; 9462-9469 were B.E.2Cs with Curtiss OX-5; 9470-R.A.F.1a engine; 9471-9475 were B.E.2Cs with Curtiss OX-5; 9951-10000 were built by Blackburn.

War Office Orders.—A.1261-A.1310 were B.E.2Cs, changed to 2Es, built by Barclay, Curle: A.1311-1360 were B.E.2Cs, changed to 2Es, built by Napier and Miller; A.1361-A.1410 were B.E.2Cs, changed to 2Es, built by Denny Bros.; A.1792-A.1891 were B.E.2Cs built by Vulcan; A.2733-A.2982 were B.E.2Es built by British and Colonial: A.2815-No. 16 Sqn., Richthofen's 39th victory, 8.4.17; A.3049-A.3148 were B.E.2Es built by Wolseley; A.3149-A.3168 were B.E.2Es; B.719 and B.728 were B.E.2Es; B.3651-B.3750 were B.E.2Es built by Vulcan Motor Co.; B.4401-B.4600 were B.E.2Es built by British and Colonial; B.6151-B.6200 were B.E.2Cs built by British Caudron; C.1701-C.1750 were B.E.2Es ordered from British and Colonial, but cancelled; C.6901-C.7000 were B.E.2Es built by Denny Bros.; C.6965, owned by Perdrian Rubber Co. in Australia in 1920: C.6986, used by QANTAS Co., Ltd., in 1921; C.7001-C.7100 were B.E.2Es built by Barclay, Curle; C.7086-No. 2 Sqn.; C.7095, used by Americans at Ford Junction; C.7101-C.7200 were B.E.2Es built by Napier and Miller; F.4096 and F.4160-B.E.2Es.

N.B. Wherever possible, the type designation quoted is that under which the contract was originally placed. It must be borne in mind that much modification and rebuilding went on with the early B.E.s, and that machines ordered as B.E.2Cs or 2Ds were often delivered as, or modified to be, B.E.2Es. Where a type of engine is quoted against a machine or batch of machines, it is the type originally fitted to or ordered for the aircraft in question.

FORTHCOMING EVENTS

April 22. Guild of Air Pilots and Air Navigators: A. G. M.
April 22. R.Ae.S. Main Lecture: "Diesel Compound Engines," by E. E. Chatterton, B.Sc., A.M.I.Mech.E., F.R.Ae.S.
April 24. British Interplanetary Society (North-west branch): Film show.
April 24. British Interplanetary Society (Provisional Western branch): Exhibition and film show.
April 27. R.Ae.S. Section Lecture: "Aerodynamic and Aeroelastic Characteristics of the Crescent Wing," by G. H. Lee, B.Sc., D.I.C., A.R.C.S., F.R.Ae.S.
April 28. Aéro-Club d'Italie: International helicopter meeting.
April 29. R.Ae.S. Graduates' and Students' Section: "Fuselage Structural Design Methods," by R. J. Jupe, A.F.R.Ae.S., G.I.Mech.E.
May 3-14. British Industries Fair, London and Birmingham.
May 4. R.Ae.S. Section Lecture: "Propellers for High-Speed Aircraft," by G. C. I. Gardiner, A.F.R.Ae.S.
May 6. R.Ae.C.: Annual general meeting.
May 9-16. Saar Aero Club: International gliding contest and rally.
May15-17. Channel Islands Aero Club: International rally, St. Peter's Airport, Jersey.
May 20. R.Ae.S.: 42nd Wilbur Wright Memorial Lecture: "The Choice of Power Plants for Civil Aeroplanes," by Dr. A. E. Russell, B.Sc., F.I.A.S., F.R.Ae.S.
May 22. Leicestershire Aero Club: Air display.
June9-19. Mechanical Handling Exhibition and Convention, Olympia.
June 13. R.Ae.S. Garden Party, London Airport.
June21-24. Institute of the Aeronautical Sciences: Annual summer meeting, Los Angeles.
June26-27. Aéro-Club de Flers de l'Orne: Normandie Rally.
R.Ae.S. Branch Fixtures (to April 30).—April 23, *Hatfield*, annual dinner. April 28, *Coventry*, annual general meeting and films: *Southampton*, "Recent Developments in Civil Engineering," by Dr. A. G. Pugsley. April 30, *Birmingham*, "Aircraft Electrics," by R. H. Woodall and J. H. Rea.

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★ The Sapphire is manufactured under licence by the Wright Aeronautical Division of the Curtiss-Wright Corporation in the U.S.A., where it is known as the Wright J.65.

The vital strategic importance of the Sapphire is emphasized by the fact that it is chosen to power the following aircraft, for the air forces of the N.A.T.O. powers . . .

THE HAWKER HUNTER F.2 *fighter*
THE GLOSTER JAVELIN *all-weather fighter*
★ **THE REPUBLIC F.84F** (*Thunderstreak*) *fighter*
THE HANDLEY PAGE VICTOR *crescent-wing bomber*
★ **THE MARTIN B57** (*Canberra*) *bomber*

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AIRCRAFT INTELLIGENCE

UNFAMILIAR: Since Britain is not an "outback" part of the globe, twin-float seaplanes are a rarity; in fact, it appears that none is on our civil register. These two trim examples are (top) the French N.C.856-H and (lower) the Cessna 180 fitted with Edo floats which retail at £1,400 the pair.

Great Britain

Percival P.87. Our contemporary, *American Aviation*, reports that this new twin-engined transport project is designed around a pair of Napier low-pressure gas-producer engines, probably Oryx. They would be mounted in the wing with leading-edge intakes, a duct leading the hot gas to power turbines mounted at the rear. These turbines would extract nearly all the energy from the gas-flow, so that the resulting efflux would contain little heat or kinetic energy. As a result, the efflux could be ejected close to the propeller blade-roots without the latter coming to harm; at the same time, the installation should prove unusually quiet.

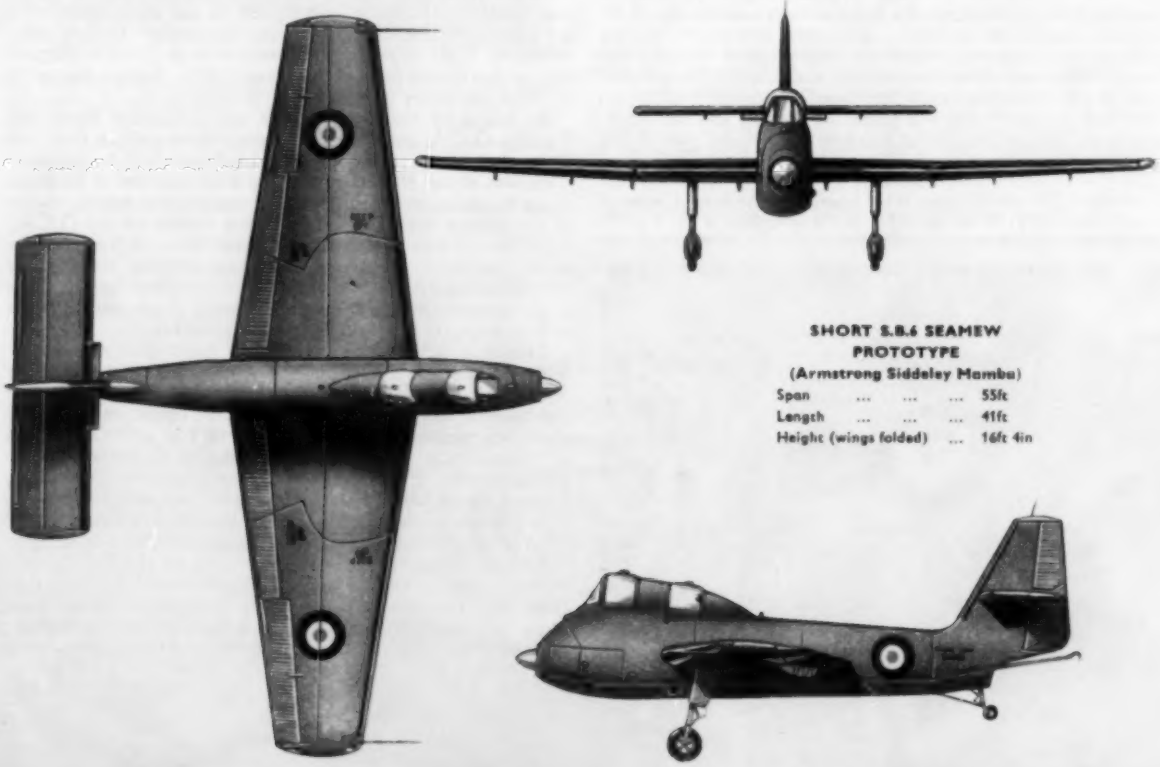
U.S.A.

Convair R3Y Tradewind. Production of this impressive "four-times-two" turbo-prop transport boat for the U.S. Navy is now well under way; recent photographs of the same company's XFY-1 v.t.o. fighter have shown, in the background, upwards of three Tradewinds on the ramp.

Douglas A3D Skywarrior. This recently announced name is particularly appropriate to the massive A3D carrier-based bomber which, as we said in our recent "Fifty Years of Powered Flight" issue, "epitomizes seaborne air power." Production Skywarriors are now flowing from the El Segundo plant, with podded J57s.

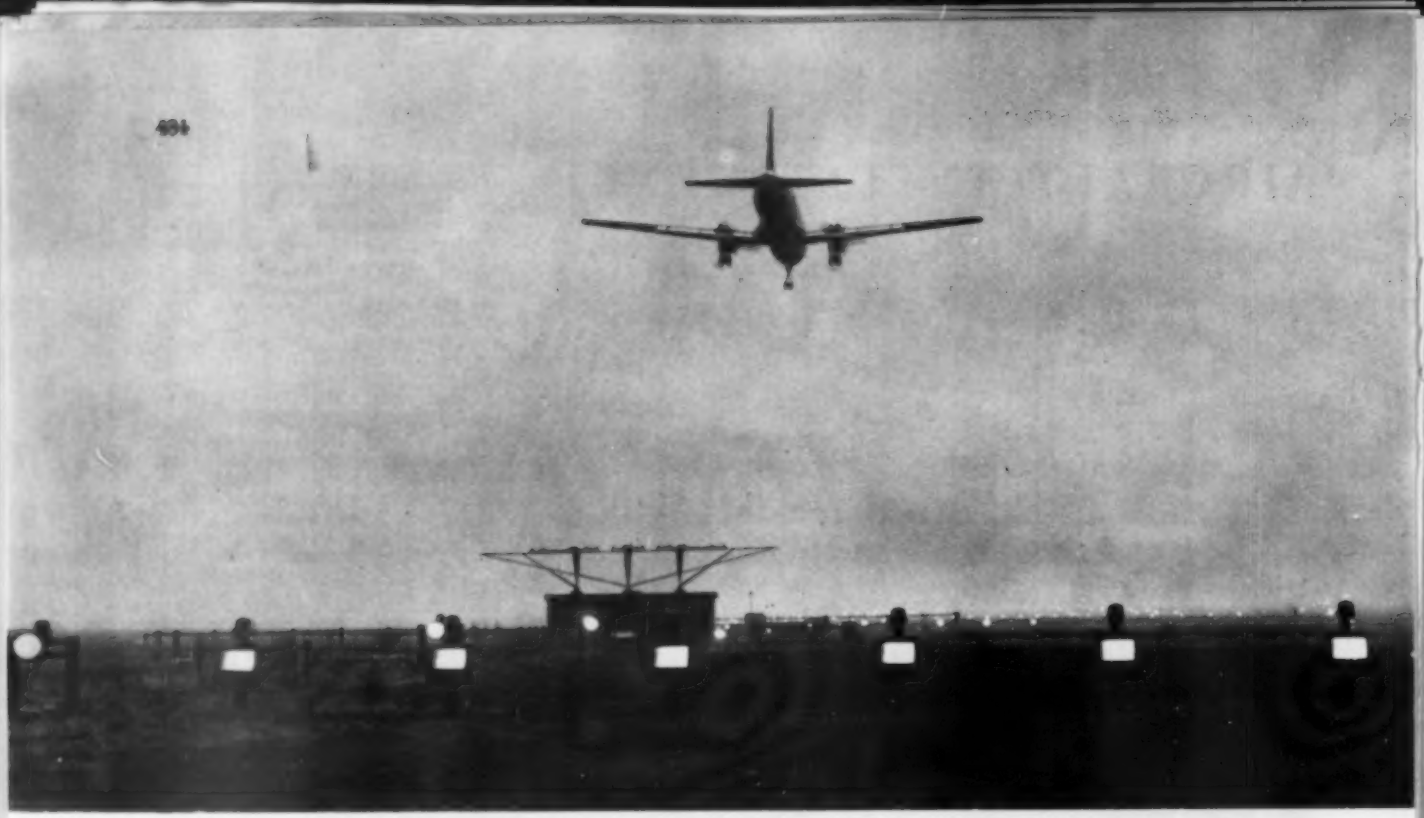
Lockheed XF-104. Latest from the Lockheed stable, this aircraft maintains the family tradition of being a good-looker. It is very rakish, with a tall fin and short, straight wings of very low thickness/chord ratio, and is fitted with a variety of moving surfaces, including an unusual control system. The designation is "air-superiority fighter," i.e. a straightforward fighter, as distinct from a short-duration intercepter or a big all-weather fighter. Single-seated and single-engined, the prototype is now in the third week of U.S.A.F. Phase I flight testing at Edwards A.F.B.; the power unit is a J65 Sapphire.

Vought Cutlass. Although the Westinghouse J46 turbojet has come in for more than its share of development troubles, the aircraft which it powers—the Cutlass—is rapidly becoming a factor to be reckoned with. (In all fairness, the J46 itself is clearly through most of its viscissitudes, and may yet prove itself an efficient engine.) The Cutlass is in full production at Chance Vought's Dallas plant in three main forms: F7U-3 standard fighter; F7U-3M missile-launcher; and F7U-3P photo-reconnaissance machine. Production will be soon concentrated on a revised Cutlass, designated A2U and specially equipped for ground attack. It will be heavily armoured, will have a revised fuel system, and will carry a heavy external load; other equipment includes Hamilton Standard refrigeration and a G.E. pitch and yaw damper. In under a year's time, the Dallas plant should switch to the impressive new F8U, a supersonic carrier fighter, with an afterburning J57 and a variable-incidence wing.



SHORT S.B.6 SEAMEW
PROTOTYPE
(Armstrong Siddeley Mamba)

Span	...	...	...	55ft
Length	...	...	...	41ft
Height (wings folded)			...	16ft 4in



"Talk-down completed." A Convair 240 of Swissair passes over Calvert approach lights to touch down on Runway 10R at London Airport.

London Talk-down

"FLIGHT" Photographs

LONDON Airport is acquiring an extremely high reputation and there is no doubt that when the new passenger and control buildings are completed this terminal will be a model one in every respect. Meanwhile, L.A.P. provides airlines with a wealth of aids to safe and regular operation: fine runways, the best approach lighting system in the world, excellent radio and radar aids, and efficient control staff.

It was recently our privilege to observe an I.L.S./G.C.A. landing from the cockpit of a large airliner arriving by night in very unpleasant weather. We were impressed by the smooth precision with which we were guided through the control zone and on to the runway, and also by the admiration of our American crew for London Airport's facilities. The G.C.A. talk-down was particularly good and we determined as soon as possible to examine the ground part of the system. L.A.P. is one of six civil airports in this country to be equipped with G.C.A. Civil operation of the American-built Federal radar equipment began there early in 1947 and the total number of G.C.A. landings made at London has since passed the 38,000 mark. London is the only British airport with two complete G.C.A. caravans, providing insurance against the unlikely event of failure of one set and allowing quick change of landing direction.

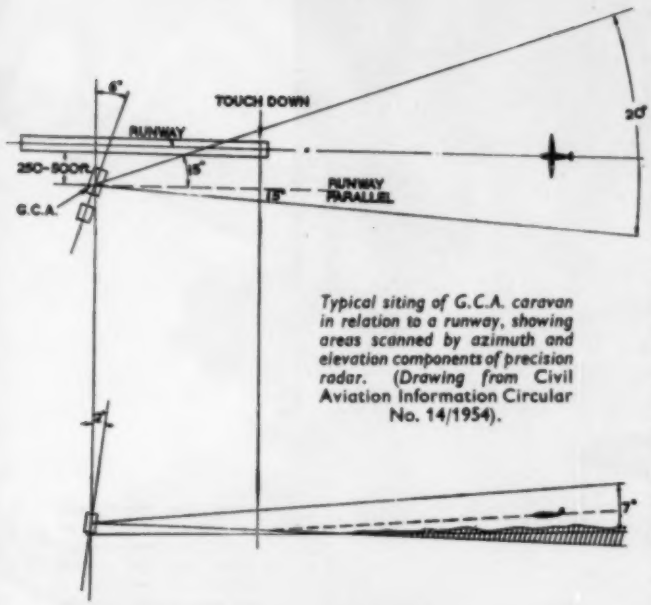
Inside the G.C.A. van the stage is set (apart from the lighting required to take the picture) for an approach. In the foreground is No. 2 traffic director, with the talk-down controller and tracker (far corner) on his left.

The efficiency of the training provided by the M.T.C.A. control school at Hurn is reflected in the exceptional proportion of 98 per cent "first-time successful" G.C.A. talk-downs at U.K. airports. One controller at London Airport told us that in two years of unbroken G.C.A. duty he has never found it necessary to order an overshoot.

As might be expected, British winter weather keeps the London G.C.A. controllers extremely busy and, in fact, last December saw a record total of 1,467 full G.C.A. landings. This was about 85 per cent of the total number of landings made by transport aircraft at L.A.P. during that month. Some of the airlines operating into London always ask for G.C.A., regardless of weather, to provide their crews with experience which cannot be obtained at their home airfields. Midsummer usually gives the G.C.A. crews more frequent breaks from their exacting duties, although the onset of autumn brings a rash of requests for practice radar approaches.

Even in aviation circles there are a number of misconceptions about the workings of the system, because only those few people who are actually at the sending or receiving end can become thoroughly familiar with the operation of G.C.A. Our own confidence in flying by airline in all weathers has more than once been greatly strengthened by listening-in to a G.C.A.—either on the flight-deck of an aircraft descending through cloud, with wheels and flaps down, towards the unseen runway ahead, or in the equally confined controllers' caravan, flickeringly lit by the green glow of the radar scopes.

Two complete radar systems are used by the G.C.A. controllers to bring an arriving aircraft from about 26 nautical miles from the airfield to a point 400 yd from the touch-down area. The search system provides a radar map of the circuit, and the precision system has two aerials and two scopes giving



Typical siting of G.C.A. caravan in relation to a runway, showing areas scanned by azimuth and elevation components of precision radar. (Drawing from Civil Aviation Information Circular No. 14/1954).

With W/C. R. F. Bulstrode (in duffle coat), London Airport's air traffic controller-in-charge, are pictured a representative G.C.A. team (left to right): Mr. B. E. J. Heard, final controller; Miss D. R. Colter, tracker; Mr. E. C. Mather, supervisor; Mr. G. H. Bayes, director; and Mr. P. D. Borcherds, director.

azimuth and elevation information for the final part of the approach (see adjacent diagram).

Our visit was made in perfect G.C.A. weather, with eight-eighths cloud at 600ft and visual range for the runway in use (10R) of 1,200 yd. In quick succession, a B.E.A. Elizabethan, a Swissair Convair and an Air France DC-4 made flawless approaches. In each case the work of the G.C.A. team began with identification of the aircraft over Epsom by No. 1 Traffic Director, using the search radar. The aircraft was then transferred to No. 2 Traffic Director, also using search radar, whose job was to line up the aircraft for talk-down approach from a range of eight nautical miles. The Talk-down Controller, assisted by the Tracker, then took over, both using the precision radar.

The Traffic Director issues *instructions* to the pilot but the Talk-down Controller does so only if the aircraft is making a full G.C.A.; when the pilot elects to make an I.L.S. approach and asks for monitoring by G.C.A. the Talk-down Controller gives information only. Certain precision systems provide the Talk-down Controller with both azimuth and elevation ("azel") scopes showing the movement of the aircraft in relation to, respectively, the centre-line of the runway and the specified glide-path.

Equipment used at London Airport, however, provides the Controller with azimuth scopes only. The elevation scope is watched by the Tracker, who uses a combined manual and electronic computing system to give the Controller a simplified picture of the aircraft position in relation to the glide-path. This takes the form of a needle (representing the aircraft) which moves on a scale graduated in tens of feet above or below the glide-path. The Tracker also notes the distance of the aircraft from touch-down, which he (or she) calls out to the Controller for transmission to the pilot.

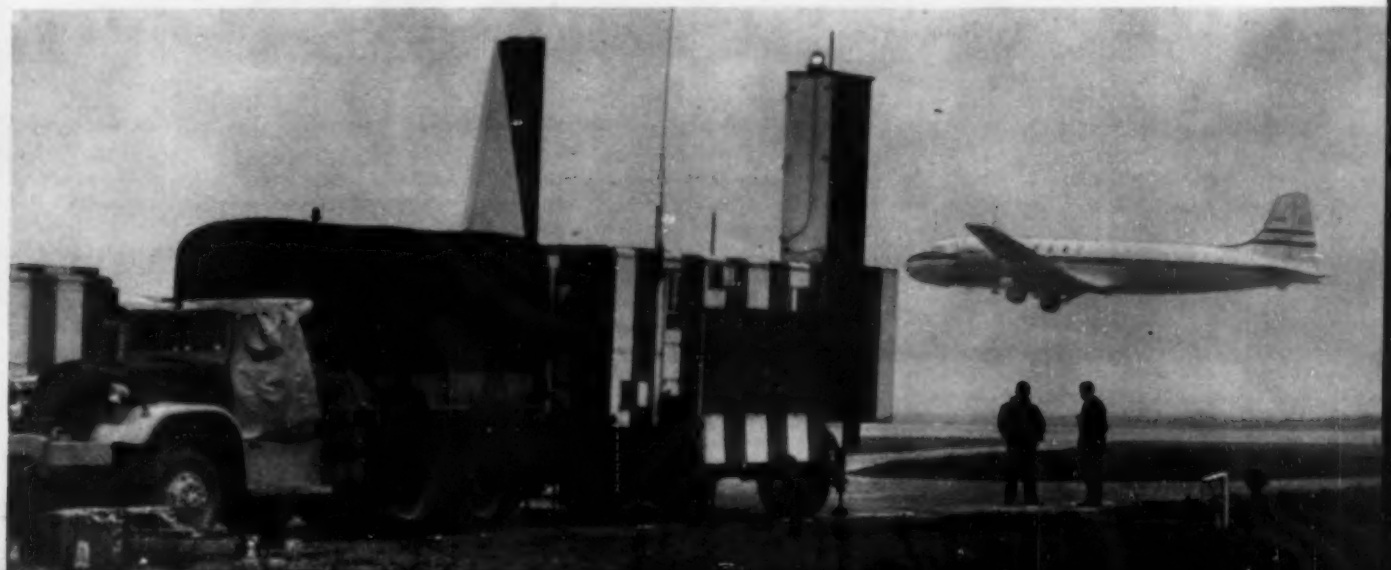
Two azimuth scopes are used by the Controller—one long-range screen covering eight nautical miles with concentric rings at two-mile intervals, the other a short-range screen with four half-mile graduations. The short-range display is almost as informative as a television screen, providing a clear indication of the Calvert cross-bar lights, the runway threshold and the runway itself.

To prevent misinterpretations by the pilot, transmissions by the Traffic Director and Controller conform very closely to a pre-determined "patter". An idea of the procedure is given by these typical extracts:—

Traffic Directors (1 and 2): "Able King—you are identified . . . you are cleared to leave Epsom . . . heading 280 . . . descend to 2,500ft . . . turn right . . . heading 300 . . . you are five miles south-west of London on downwind leg . . . continue descent to 1,500ft . . . QFE touch-down is 1010 . . ."

Talk-down Controller: "Able King—this is London talk-down . . . How do you read me? Over . . . Roger, do not acknowledge any further instructions . . . your heading is good, you are six miles from touch-down . . . begin your descent now at 500ft/min . . . check your wheels down and locked . . . your heading of 105 is good, very steady on the glide path . . . turn left left three degrees . . . you are two miles from touch-down, heading good, on the centre-line, on the glide-path . . . 400 yards from touch-down . . . talk-down completed." R.B.

(Below) *Mobile operations room at London Airport. In the background, a B.O.A.C. Argonaut has just "unstuck" from Runway 10R.*



Rarely does the camera capture the beauty of flight so perfectly as here; and the picture serves as a reminder, if one were needed, that the Hunter is one of the most graceful machines ever built. Incidentally, Bitteswell is also the home of Armstrong Whitworth aircraft, part of whose production consists of Sapphire-Hunter 2s.

Engineering Gems in Perfect Settings

ENGINE-DEVELOPMENT flying may be one of the less romantic forms of test-flying, but no one could disagree with our choice of title for these three studies. Two aircraft are involved: the first Sapphire-Canberra, WD933, and the first Sapphire-Hunter, WB202. Both operate, together with a motley array of other jet, turboprop and rocket test-beds, from the Armstrong Siddeley airfield at Bitteswell, near Rugby. The company's four test pilots, Lt. Eddie Griffiths, R.N. (chief), Lt. Peter Aked, R.N., F/L. A. H. ("Wit") Wittridge, R.A.F., and F/L. Lyndon ("Pee-Wee") Griffith, R.N.Z.A.F., are making a man-size contribution to the development of a range of superb power plants.

On the left is A.S.M.'s high-flying Canberra, which has enabled the Sapphire to be tested at some 60,000ft. (Above) An oblique shot of pleasant Midland farmland, crossed by the Sapphire-Hunter in a tight turn, Lombard-helmeted figure in cockpit.

Three of the Seven

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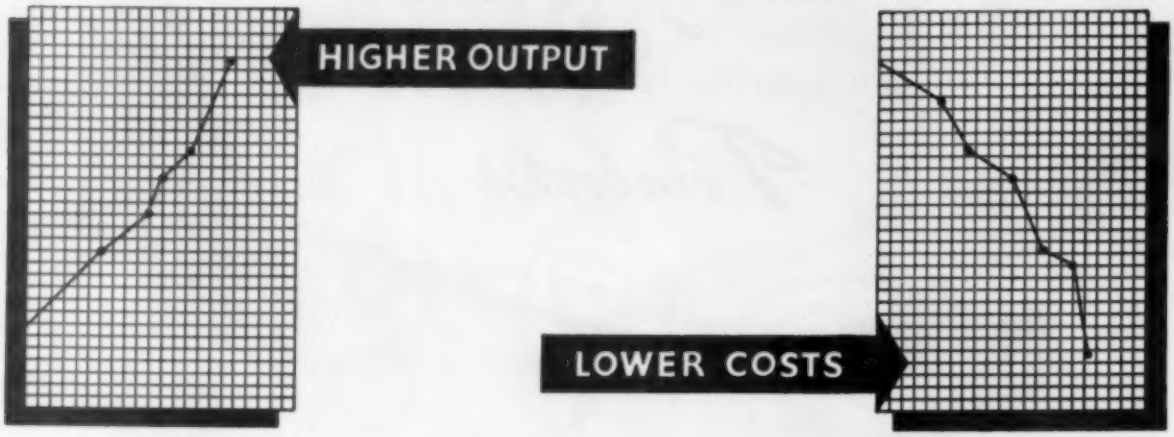

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IMPERIAL RECORD

A Chronology of Britain's Former National Airline

COMPILED By JOHN STROUD

ONE of the greatest stories of air-transport achievement is that of the British national airline Imperial Airways, which came into being a little over 30 years ago—on March 31st, 1924. Formed from four pioneer companies, it had a small fleet—only four aeroplanes of which were twin-engined—and began work on short European routes.

This company, with limited resources but with great drive, surveyed, opened and developed a series of trunk routes stretching to Australia, Hongkong, South, East and West Africa and a regular mail service to North America. Aerodromes had to be prepared and in some areas it was even necessary to build forts in which passengers could safely spend the night.

When the company was incorporated into the present British Overseas Airways Corporation a sound system of world air routes had been firmly established and many of the small band of men and women who built that great system still constitute the backbone of British air transport.

1924

March 31st: Imperial Airways, Ltd., incorporated as the "chosen instrument" of the British Government, with the mission of developing British commercial air transport on an economic basis. The company was formed out of and took over the fleets of Handley Page Transport, Ltd., the Instone Air Line, Ltd., the Daimler Airway, and British Marine Air Navigation Co., Ltd. Original subsidy agreed as £1,000,000 spread over ten years, to be paid on declining scale. First chairman Sir Eric Geddes, managing director Lt. Col. Frank Searle, general manager George Woods Humphery. Total staff at incorporation, 260, including 19 pilots. Fleet: Three Handley Page W.8bs, two Supermarine Sea Eagles, one Vickers Vimy Commercial and seven D.H.34s.

A D.H.34 operated Imperial Airways' first service (London-Paris, 26.4.24).

April 26th: First service flown, London - Paris, by D.H.34 G-EBCX (Capt. H. S. Robertson). Earlier working prevented by pilots' strike.

May 1st: Southampton - Guernsey service re-opened.

May 2nd: London - Cologne service re-opened.

May 3rd: London - Brussels - Cologne and London - Ostend - Cologne services opened.

June 2nd: London - Amsterdam - Hanover - Berlin service opened in collaboration with Deutsche Aero-Lloyd.

June 17th: London - Paris - Basle - Zürich service re-opened.

November 3rd: First three-engined aeroplane commissioned: Handley Page W.8f, G-EBIX, *City of Washington.*

1925

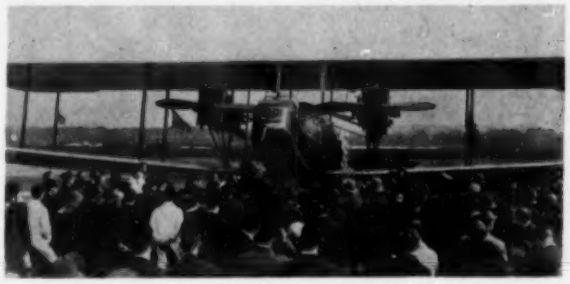
May 15th: London - Amsterdam service became first sector of first through England - Scandinavia service. Swedish Air Lines flew Amsterdam - Copenhagen - Malmö sectors.

August 31st: Operational, technical and commercial survey of Cairo - Karachi route begun by party representing Imperial Airways and Air Ministry.

October 1st: Cairo - Karachi route survey completed.

1926

March 31st: Five new Handley Page airliners inspected by Dominion Prime Ministers at a naming ceremony at Croydon: W.9 G-EBLE *City of New York*, W.10s G-EBMM *City of Melbourne*, G-EBMR *City of Pretoria*, G-EBMS *City of London* and G-EBMT *City of Ottawa.*



Naming the Handley Page W.10 "City of Pretoria," Croydon, 31.3.26.

July 16th: Armstrong Whitworth Argosy G-EBLO *City of Birmingham* commissioned on London - Paris route.

1927

January 7th: Fortnightly Basra - Baghdad - Cairo mail and passenger service began, timed to connect with P. and O. mail-boat service Marseilles to Port Said. De Havilland Hercules aircraft used on this first British eastern route. First eastbound service January 12th.

April: London - Paris and Paris - London "Silver Wing" services began with Argosy aircraft.

July 15th: London - Le Touquet service opened.

October: Second-class services introduced on London - Paris route.

1928

July 26th: First Short Calcutta flying-boat commissioned: G-EBVG, later named *City of Alexandria.*

September 24th: Temporary Liverpool - Belfast mail and passenger service began, using Calcutta flying-boats. Service closed October 4th.

1929

February 28th: Southampton - Guernsey route closed.

March 30th: England - India weekly service opened *via* Paris, Basle, Genoa, Rome, Naples, Corfu, Athens, Suda Bay, Tobruk, Alexandria, Gaza, Rutbah Wells, Baghdad, Basra, Bushire, Lingeh, Jask and Gwadar, with terminal at Karachi. London to Basle by Argosy, Basle - Genoa by train, Genoa - Alexandria by Calcutta, thence by Hercules.

June 14th: "Tea flights" begun. These cost passengers £2 2s and were made over London at week-ends in summer, tea being served aboard. Price reduced to £1 10s in 1931. Last operated in 1932.

November 2nd: All-air route to India opened. European sector *via* Cologne, Nuremberg, Vienna, Budapest, Belgrade, Skoplje to Salonica where flying-boats took over. Bad weather caused abandonment of this route on November 16th, after which passengers and mail were carried by rail between Cologne and Athens.

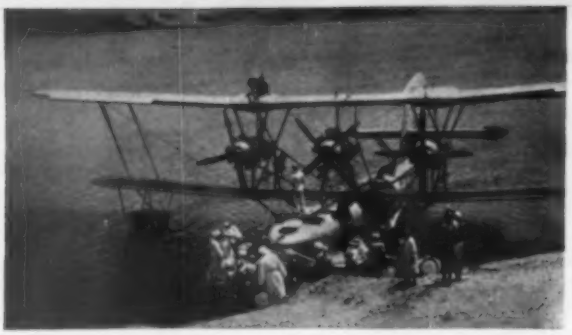
November 11th: Operational, technical and commercial survey of Cairo to Cape Town route begun by Imperial Airways and Air Ministry.

December 21st: London - Karachi service extended to Jodhpur.

December 30th: London - Jodhpur service extended to Delhi.

During the year Air Ministry concluded new agreement with

First I.A.L. machine in Nyasaland: D.H.66 Hercules, "City of Karachi."



Short Calcutta "City of Stonehaven," on the Nile at Kareima.

"Horsa" (H.P. Hannibal class), at Khartoum, on the South Africa route.

IMPERIAL RECORD . . .

Imperial Airways for period of ten years. European service subsidies were to be increased to £125,000 per annum for 1929-30, £110,000 for each of next four years and then £30,000 for 1938-39.

1930

April 11th: Cairo - Cape Town route survey completed.

April 12th: England - India route again began to be all-air except for rail sector Skoplje - Salonica. Time reduced to six-and-a-half days.

June 16th: Experimental London - Birmingham - Manchester - Liverpool route opened mainly to offer connections with Continental services at Croydon. Argosy aircraft used. Route closed September 20th.

1931

February 28th: Weekly England - Central Africa service began with terminal at Mwanza, Tanganyika Territory. Passengers carried only as far as Khartoum.

"Sylvanus," one of the three Short Kents used in the Mediterranean.

April 4th: London - Delhi service extended experimentally for mail only to Australia. Mail picked up by Charles Kingsford Smith at Koepang and flown to Darwin, thence by Q.A.N.T.A.S. to Melbourne.

April 11th: England - India service accelerated to five-and-a-half days.

April 25th: Second experimental Australian mail carried from Akyab to Sydney by Kingsford Smith.

April 27th: G-ABFA *Scipio*, first of three Short Kent flying-boats commissioned. Others were G-ABFB *Sylvanus* and G-ABFC *Satyrus*.

May 16th: European sector of Empire routes reverted to London - Basle by air, Basle - Genoa by train thence by air.

June 11th: Four-engined Handley Page Hannibal began to operate on London - Paris route. This was first of fleet of Hannibal class for Empire and Heracles class for European routes. Original fleet: Hannibal class—G-AAGX *Hannibal*, G-AAUC *Horsa*, G-AAUD *Hanno*, G-AAUE *Hadrian*. Heracles class—G-AAXC *Heracles*, G-AAXD *Horatius*, G-AAXE *Hengist* and G-AAXF *Helena*.

September 11th: Heracles operated on London - Paris route for first time.

October: Trans-Mediterranean sectors of England - India and England - Central Africa routes separated. Became London - Paris by air, Paris - Brindisi by rail then to Athens by air, where routes became; to India *via* Castelrosso - Haifa by air, Haifa - Tiberias by car and Tiberias - Karachi by air. To Africa *via* Mirabella and Alexandria.

December 9th: London - Mwanza service extended experimentally to Cape Town with Christmas mail.

1932

January 20th: England - Central Africa service extended for mail only to Cape Town *via* Nairobi, Dodoma, Salisbury and Johannesburg. Kisumu - Mwanza sector abandoned. Time to Cape Town, eleven days. Croydon - Paris by Heracles, train to Brindisi, Scipio to Alexandria, train to Cairo, Argosy to Khartoum, Calcutta to Kisumu and thence by Hercules.

April 27th: Weekly London to Cape Town service opened in both directions for carriage of passengers.

October 1st: India route diverted to Arabian side of Persian Gulf from Basra *via* Koweit, Bahrein, Sharjah and Gwadar instead of *via* Bushire, Lingeh and Jask.

October 26th: Armstrong Whitworth Atalanta four-engined monoplane first flew on London - Brussels route and subsequently on Paris - Basle - Zürich route before going on Empire routes. Eight aeroplanes in class.

1933

February 18th: First 10,000,000 miles of flying completed.

March 15th: Premium for personal accident insurance on company's routes reduced from 12s to 1s per £1,000.

June 21st: Indian Trans - Continental Airways formed to operate trans-India route in association with Imperial Airways.

July 1st: London - Karachi service extended to Calcutta.

September 23rd: London - Calcutta service extended to Rangoon.

December 9th: London - Rangoon service extended to Singapore.

1934

January 18th: Qantas Empire Airways formed to operate trans-Australian route in association with Imperial Airways.

March 21st: Railway Air Services formed, by four main-line railway companies and Imperial Airways, for the operation of British internal services.

May 16th: G-ACJJ *Scylla*, first of two Short L.17 four-engined biplanes, commissioned on European services.

November 17th: Flat rate for air mail introduced to certain destinations on Empire routes: 3d. per ½ oz to Near East, 6d. for East and South Africa, India and Malaya.

December 8th: London - Singapore service extended to Brisbane for carriage of mail. Singapore - Brisbane section worked in association with Qantas Empire Airways.

December 20th: H.M. Government announced the Empire air-mail scheme (later, "Empire air-mail programme"): Beginning in 1937, all letters despatched from the United Kingdom for delivery along the Empire routes would, so far as practicable, be carried by air without surcharge.

1935

April: London - Brussels - Cologne - Prague - Vienna - Budapest and London - Rome - Brindisi services opened by Diana-class D.H.86s.

April 7th: Weekly Brisbane - London service opened for carriage of passengers. London - Brisbane service began on April 13th.

1936

February 9th: Weekly London - Kano (Nigeria) air-mail service began *via* Khartoum. Kano - Khartoum sector by Diana class.

March 14th: Weekly London - Hongkong service began *via* Penang; Diana class from Penang to Hongkong.

March 24th: South African Airways took over operation of Imperial Airways' Johannesburg to Cape Town sector of the England - South Africa route.

August 22nd: Imperial Airways (Bermuda), Ltd., formed.

October 15th: London - Kano service extended to Lagos.

October 30th: G-ADHL R.M.A. *Canopus*, first of the four-

"Astraea" (A.W.A. Atalanta class) at Seletar, Singapore.

engined Short C-class Empire flying-boats, made first scheduled flight on a trans-Mediterranean service.

December 21st: G-ADHM, R.M.A. *Caledonia*, first long-range Empire flying-boat, flew Alexandria - Marseilles 1,700 miles in 11¼ hr. On December 22nd it flew Marseilles - Southampton in 4¼ hr.

1937

January 12th: First all-air trans-Mediterranean service operated by Empire flying-boat. Alexandria - Southampton. First service outward bound left Southampton on January 16th and flew *via* Mirabella, Rome, Brindisi and Athens, reaching Alexandria on January 17th.

February 8th: Regular Southampton - Alexandria services began.

February 18th: R.M.A. *Caledonia* flew non-stop from Southampton to Alexandria 2,222 miles in 13 hr 5 min.

March 5th: Hythe Base opened for operation of Empire services; Croydon thereafter used only for European services.

April: London - Budapest services re-routed to call at Frankfurt to connect with German Zeppelin services.

May 2nd: Heracles completed the company's 40,000th flight across the English Channel.

May 15th: Empire flying-boats took over Africa route as far as Kisumu.

May 22nd: 1,000th service from United Kingdom to Empire.

May 23rd: First service flight from Alexandria to Southampton in one day.

May 25th: G-ADUU, R.M.A. *Cavalier*, made first survey flight Bermuda - New York. Pan American Airways' Sikorsky S-42 made flight in opposite direction.

June 2nd: First all-flying-boat service England - South Africa. Flown by R.M.A. *Canopus* from Southampton to Durban *via* Marseilles, Rome, Brindisi, Athens, Alexandria, Cairo, Wadi Halfa, Khartoum, Malakal, Butiaba, Port Bell, Kisumu, Mombasa, Dar-es-Salaam, Lindi, Mozambique, Beira, Lourenço Marques. The route had optional stops at Macon, Mirabella, Luxor, Kareima, Laropi, Quelimane and Inhambane.

June 4th: R.M.A. *Cambria* completed 20,000-mile survey of African routes.

June 16th: Joint Imperial Airways and Pan American Airways Bermuda to New York service opened. First service in opposite direction, June 19th.

June 18th: Nominal capital of Imperial Airways increased from £1,000,000 to £5,000,000.

June 29th: Empire air-mail programme inaugurated between England and Sudan, East and South Africa when R.M.A. *Centurion* left Southampton with 3,500 lb of unsurcharged mail.

July 5-6th: First commercial survey flights over North Atlantic by Imperial Airways Empire flying-boat R.M.A. *Caledonia* and Pan American Airways' Sikorsky S-42 *Clipper III*. These were first of a series made by Caledonia, Cambria and the Clipper.

July 6th: First survey flight Southampton - Lisbon by R.M.A. *Cambria*.

July 23rd: Heracles completed 1,000,000 miles of flying in 10,200 hr, having carried about 80,000 passengers.

September 6th: R.M.A. *Ceres* left Alexandria on first Empire flying-boat survey flight to Karachi.

October 3rd: R.M.A. *Clio* left Southampton for Alexandria on first Empire flying-boat service to Karachi. R.M.A. *Calypso* operated the Alexandria - Karachi sector.

October 6-7th: R.M.A. *Caledonia* made first Southampton - Azores survey flight.

October 13th: R.M.A. *Delia*, Diana class, left Lagos on first service to Accra. Service operated by Elders Colonial Airways in association with Imperial Airways.

October 15th: Short Kent flying-boat *Satyrus* left Alexandria on survey flight to Singapore.

November 15th: R.M.A. *Cordelia* left Karachi on first Empire flying-boat survey flight to Singapore.

December 3rd: R.M.A. *Centaurus* left Southampton on first Empire flying-boat survey flight to Australia and New Zealand.

December 8th: Horatius carried 250,000th passenger flown across the English Channel by Heracles class.

December 19th: Hongkong route altered to fly *via* Bangkok, Udorn, Hanoi and Fort Bayard instead of *via* Penang, Saigon and Tourane. First Bangkok - Hongkong service flown by R.M.A. *Delphinus*; service in opposite direction on same day by R.M.A. *Dorado*.

December 27th: R.M.A. *Centaurus* left Sydney on survey flight to Auckland.

"Calypso" (Short C-class) departs for Australia with first "all-up" mails.

"Frobisher," first of the D.H.91 Albatrosses used on European services.

1938

January 20th: First flight-refuelling test with Empire flying-boat, carried out under direction of Sir Alan Cobham.

February 6th: First separation test of the Short-Mayo Composite aircraft.

February 23rd: Empire air-mail programme inaugurated to Egypt, India, Ceylon and Malaya. Mail left Southampton aboard R.M.A. *Centurion*.

April 10th: England - Durban route-time reduced from over six days to four-and-a-half days.

June 26th: First through flying-boat service left Southampton for Australia. R.M.A. *Cordelia* and *Camilla* operated Southampton - Singapore sector and R.M.A. *Challenger* the Singapore - Sydney sector.

July 21-22nd: First heavier-than-air commercial crossing of North Atlantic: R.M.A. *Mercury*, upper component of the Mayo Composite, separated from *Maia* near Foynes and flew non-stop to Montreal, 2,930 miles, in 20 hr 20 mins. Then continued to Port Washington, New York.

July 28th: Empire air-mail programme inaugurated to Australia, New Zealand, Tasmania, Fiji, Papua, Norfolk Island, Lord Howe Island, Nauru, Mandated Territory of Western Samoa and the Territories under the jurisdiction of the High Commissioner for the Western Pacific. Mail left Southampton aboard R.M.A. *Calypso*. From then Qantas Empire Airways began through operation to Southampton.

September 2nd: Empire air-mail programme extended to include Hongkong. First all-up mail left Hongkong for Bangkok to connect with Australia - England service.

October 6-8th: Mercury flew non-stop from over Dundee to Orange River, South Africa, 6,045 miles in 42 hr 5 min, creating a world long-distance record for seaplanes.

During 1938 Imperial Airways made a series of North Atlantic experimental flights with C-class Empire flying-boats using flight refuelling. Towards the end of the year the Armstrong Whitworth Ensign and de Havilland Frobisher-class Albatross airliners began operation on European routes.

1939

January 10th: R.M.A. *Frobisher* made a record flight from Croydon to Brussels, 200 miles in 48 mins.

April 4th: Experimental flight Lagos - Takoradi by Elders Colonial Airways. Regular service opened in May.

April 16th: Joint London - Paris service began with Imperial Airways and British Airways. Eight services operated each way on weekdays all with Frobisher-class airliners. Schedule, 70 min.

June 12th: British Overseas Airways Corporation Bill, for the merger of Imperial Airways and British Airways, introduced in the House of Commons by Sir Kingsley Wood.

July 10th: British Overseas Airways Corporation Bill given second reading in the House of Commons.

August 4th: Royal Assent given to the British Overseas Airways Corporation Bill.

August 5th: Southampton - Montreal - New York regular mail service opened by R.M.A. *Caribou*.

September 2nd: All-up mail services suspended and air-fee services revived.

September 3rd: Great Britain declared war on Germany.

September 22nd: United Kingdom - Egypt route opened by R.M.A. *Fortuna* (Frobisher class). Route: Shoreham - Bordeaux - Marseilles - Tunis - Malta - Sollum - Alexandria. Later extended to India and operated until Italian entry into the war.

October 13th: London - Paris route re-opened in pool with Air France. Services operated twice daily from Heston.

November 24th: British Overseas Airways Corporation established under the B.O.A.C. Act. Chairman, Sir John Reith; deputy chairman, Hon. Clive Pearson.

1940

April 1st: British Overseas Airways Corporation officially took over the operations of Imperial Airways and British Airways.

AIRLINER OPERATION

—from the Engineer's Point of View: A Recent Paper by Mr. B. S. Shenstone

BEFORE the Belfast branch of the Royal Aeronautical Society on April 6th, a paper entitled *Engineering Problems of Aircraft Operation* was presented by Mr. B. S. Shenstone, M.A.Sc., F.R.Ae.S., chief engineer of B.E.A. The lecture was originally to have been given on February 9th, but bad flying weather prevented the lecturer reaching Belfast, and a postponement to a later date became necessary in order to fit in with the arrangements of both the Belfast Branch and Mr. Shenstone. Here follows a summary of the paper, which was phrased in the author's characteristically forthright style.

The lecturer began by describing his object: to put the problems of the aircraft operator before an audience of designers and manufacturers, and to outline what the operator did about these problems. The airline engineering job was basically simple, for it was to keep the fleet flying and to bring new aircraft along to replace the existing ones.

Dealing first with the problem of new aircraft, Mr. Shenstone said that, although the operator did not want to do the manufacturer's design work, the airline would have gathered experience applicable to its new aircraft. Instances in which airline advice was essential included the size and position of the passenger door; location of freight holds; cabin width; seat spacing; galley size; electric power requirements; size of luggage racks; relative need for accessibility of certain items; and many other items. Many of these must be worked out in detail by the design staff and the airline experts in these matters, but these experts should never do the design: that was the designer's job.

The operator did not want to have to change his requirements continuously, but his job was complex and the resulting aircraft requirement was a solution to the problems of traffic, routes and politics. Seating capacity or size of the new aircraft was determined by the amount of traffic, but this traffic depended on the future level of fares, competitors' aircraft, the travel allowance, the optimum frequency and the politics of the countries on the routes. Many of these factors were changeable and the airline must change with them. The routes, also, were influenced by outside elements.

The technical side of new aircraft was sometimes easier than the contract side. The airline always wanted guaranteed deliveries tied up with liquidated damages, and required performance guarantees with damages attached [this rather esoteric phrasing can be broadly explained by saying that, should deliveries or performance fall short of their target, the customer expects compensation.—Ed.]. Finally, the airline expected the manufacturer to stand up to his design faults: if an aircraft had to be modified because of faulty design, why should the airline pay for it?

To feed the designer, the airline must have a technical staff which kept abreast of the experience of its own company and that of other airlines. Such staffs of major companies ranged in size from 100 to 250 people. These people, and many others, came into action when the new aircraft was delivered.

Proof of the Pudding

"Any new thing is imperfect," Mr. Shenstone's paper continued, "and you never really know an aeroplane until you have tried it on the public. It will have flown hundreds of hours and passed all C. of A. and other tests and still be a headache as soon as it gets into service. The cabin is hot and the cockpit is cold, or *vice versa*. The water or the doors freeze. Automatic devices are not reliable. There are radio faults. Wing skins start to crack. Water condenses in the cabin. The washing water is too hot. Windscreens collect frost or mist. The starboard wing doesn't de-ice. Cabin heaters have too short a life. Wiring is found defective. These things don't all happen to one type or to aircraft of one nationality but they are all possible."

In introducing a new type, there was always the chance of a major defect which might result in grounding it. Most new aircraft types had been grounded and there was always plenty of scope for it. These were the problems of the new aircraft; now for the problems of keeping them flying for ten years.

Ten years was a long time, but there were DC-3s which had flown more than 40,000 hours—about 15 years' work. A 10,000-hour civil transport was a young one. In the U.K., it was well to remember that the old H.P.42 never flew more than 13,500 hours, and the Short Empire boats no more than 16,000 hours. The B.E.A. Vikings were only now, after seven years, topping 10,000 hours. During that time they had had over 700 modifications, including replacement of a number of major structural members; one grounding due to airframe difficulties; and another caused by airscrew difficulties. But the Vikings had done a good job and, because of their constant development and improvement, they were now better than ever before.

A major airline must have good facilities if it was to do a good job. After seven years, B.E.A. were just getting such facilities, in the form of the new base at London Airport. In one U-shaped building were located hangars for minor and major maintenance, overhaul workshops, stores, base offices, supplies and project and development offices—in short, the whole engineering department. The total floor area was about half a million square feet, including about 200,000 sq ft of hangar area, and the total cost of the building and integral equipment was about £2½ million.

Even with the right factory, there were many engineering problems which differed from those encountered in manufacture. B.E.A. had two bases and over 60 stations, all requiring various numbers of engineers. If one included the two London stations, the Corporation had a line engineering staff of 850 and a base staff of 1,750.

The staffing of outstations abroad was an interesting problem: "We can staff such stations by sending out people from home; we can get the local airline to do our turn-rounds and minor maintenance for use; or we can employ local engineers. There is no doubt that the most expensive way of doing it is to send our own people out. If we had a stable degree of operation, probably the cheapest way would be to train natives of the country served. If our operation is variable, probably the cheapest way is to get a local airline, if such exists, to do the job. At present, practically all the work at out-stations is done by licensed engineers from home, assisted by local non-licensed labour."

When new aircraft were introduced, said the lecturer, re-training of engineers was obviously necessary, so that they could cope with the new machines. B.E.A. had set up a school in which the training both of engineers and of flight crews was carried out.

Spares and "Mods"

The stores problem of an airline was different from that of a manufacturer. Shortly after a new type of aircraft had been acquired, a large proportion of the stores bought might prove to be the wrong spares, and there might be an insufficient number of the right spares. A constant re-examination of the spares requirement took place for the first two or three years of operation of a new type of aircraft, and in this period many parts became obsolete due to modifications. One of the most difficult problems was the time taken for delivery of spares from contractors, which often caused the airlines to over-stock.

Another problem was the proportion of the man-hours required between routine and non-routine work. The latter in many cases became equal in amount to the routine work; this was serious, because non-routine work could obviously not be planned ahead in detail.

Mr. Shenstone's paper continued: "As manufacturers, you are fully familiar with the terrible problem of modification from one side. The other side is equally difficult, and it is no easy job to work the modifications into our routine maintenance. When the whole fleet is used for operation and there is no aircraft for trial installation, you can, of course, imagine how difficult it is to modify a fleet of, say, 50 aircraft within a reasonable time. Not only must we modify the aircraft, but we must modify all the spares appertaining to the modification, both at bases and at outstations."

Budgeting was important, said the lecturer. In the coming year the B.E.A. engineering department would cost about £3,700,000. About a third of this would consist of work done outside the Corporation, e.g., the overhaul of equipment and engines, and other contractual work of an engineering nature. The engineering part of B.E.A.'s total expenditure amounted to about 25 per cent.

In conclusion, the lecturer stated, the job facing airline engineers was rather like having a very long production run extending over a number of years, with each aircraft going down the line many times. Each time it left the base after an overhaul it was different in detail, because of modifications and improvements. Only by these improvements and modifications and by good maintenance techniques could the engineering costs be reduced. If no development were ever put into aircraft, improvements would be very slow. If development effort were limited to that of the original manufacturer, the improvements in economy would still be insufficient. To improve an aircraft to any extent, it required a flexible and willing manufacturer plus an active development department in the airline.

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CORRESPONDENCE

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The Corporations and the Independents

I READ, with great interest, your editorial of March 19th, on the present situation in the air transport world, and I noted with satisfaction your emphasis on the comments of W/C. Lucas —"There should be no limit to the scope for air transport operators in this country."

The field which is open to the independent operator is greatly exaggerated in uninformed circles and you would do the industry a service if you could emphasize in your columns how small it really is for these operators, with their Colonial Coach class and charter operations, as compared to that which is open to the Corporations with their guaranteed first- and tourist-class routes. Based on the latest statistics of the Corporations for the period ended October 1953, the Corporations' capacity ton mileage represented 96 per cent of British scheduled air-transport operations. When the proportion of opportunity is virtually frozen in this ratio, how can anyone honestly suggest that the independent operators threaten to undermine the activities of the public Corporations?

Your assertion that the present Government is not continuing the Socialist policy of "wet nursing" the State airlines I found a little surprising. Surely the facts speak for themselves. The largest proportion of traffic is reserved for the Corporations. They buy their aircraft on terms more favourable than those available to any other operator, in that they obtain money at low Treasury rates with no security. Unlimited credit is theirs for the asking—we have the recent additional increase in their borrowing powers as an example. Above all, the Socialist framework, whereby the dominating position of the Corporations is protected, has not been altered in law by the present Government.

Even so, let us hope that sufficient opportunity can be given to private enterprise, in the limited field now open to it, to show both Tories and Socialists that a policy of expansion in air transport, using the public Corporations and the independent operators, is not only possible, but highly desirable.

Tewin, Herts. D. SAWARD, G/C., R.A.F. (Ret.)

Employment in Canada

READING *Flight* of April 2nd, I feel that "Disappointed's" letter about "Frustration" for Englishmen in Canada calls for correction.

"Frustration" re promotion: In a certain Canadian aircraft factory the following senior positions are occupied by Englishmen: assistant chief designer, chief of preliminary design, chief of mechanical testing; group leaders—aerodynamics, mechanical, stress; several leading engineers (section leaders) in structural, mechanical, engine, electrical and stress groups.

"Frustration" re juniors: Junior men in England also do juniors' work until they grow up and qualify for senior positions.

"Frustration" re money value: Visiting England, I find that the English pound has no greater purchasing value than its exchange-rate of $2.80 in Canada. The cost of living has risen also in England. "Disappointed," being a technician, should know that, in economics, rate of exchange represents value of money. Surely he does not accuse the banks of England and Canada of cheating.

I quite agree with his last statement—that the way of life is different. It is different because the standard of living is higher in Canada; besides, when you are in Rome, do as the Romans do.

Believing that his frustrations are due to natural homesickness, I will say: Come home, Mr. Disappointed, and you will find that Canada was not a bad place to live in after all.

Manchester. VISITOR FROM CANADA.

Another Mongrel Pup?

I WAS very interested in Mr. L. T. Mason's letter, in *Flight* of February 26th, in which he refers to the two-seater "Spinning Jenny."

I wonder if this was any relation to the side-by-side dual-control machine that we flew at Rendcombe in 1917 in the R.F.C.? We called it the "Sopwith Sociable," and I was told at the time that only a few of the type had been built, as an experiment. It had been intended for giving instruction in fighting tactics but, owing to its excessive cross-sectional area, it was much too slow, and it was also pretty useless for its purpose owing to the "one-sided" views of its occupants.

Nevertheless, we had a lot of fun with it, in spite of the widespread belief that it would spin on the slightest provocation. I never provoked it.

S. J. "Squibbs" Sibley was my unofficial mentor on it. On my last flight under his gentle guidance the rotary stopped dead as we were about two or three hundred feet over the aerodrome boundary. I put the nose hard down, and then, as there was a small coppice dead ahead, tried a slight turn to port for open ground. The controls were solid! "Squibbs" had taken over in a flash and was busting himself to turn to starboard. I realized what had happened before he had time to get peeved and, letting go everything, I proclaimed him the sole owner in a very loud voice. Neither of us could see what kind of ground the other wanted to make for, and there was no time to argue. As expected, he made a perfect three-pointer after dodging the coppice.

It transpired that some bright spark had substituted a solid steel rod for a tubular tappet rod that had been reported bent. The oil had therefore failed to get to all the places intended for it.

Great relief was expressed by one and all when it was known that the one and only "Sociable" was still intact after the incident.

I don't know what eventually happened to it as, shortly afterwards, I was posted back to France.

London, W.1. JAMES CORDES.

Historical Accuracy

I HAVE a great deal of sympathy with the cautionary sentiments expressed by "Senrab" [March 5th] and Mr. C. F. Andrews [March 26th]: as one whose aim is to be scrupulously accurate in things historical I would deplore wishful thinking in this field as much as I deplore the sterile fanaticism with which some people pursue aircraft registrations, civil and military, for their own sake alone. Neither pursuit adds anything worthwhile to our aircraft history.

It is not always easy, however, to draw the line between wishful thinking and legitimate reasoning. Working backwards is always difficult in any field of history (ask the gentleman who originally "identified" the Piltdown skull), and my own feeling is that we can afford to neglect very few clues. The wrong guesses are usually exposed sooner or later.

On the question of the number of McCudden's S.E.5a, however, I have recently received positive information that it was in fact B.4891. Thanks to the assistance of Mr. S. D. Stock I now have transcriptions of three of McCudden's combat reports, two dated December 23rd, 1917, and one dated December 28th, 1917. In each case the serial number is B.4891.

I share Mr. Andrews' admiration of McCudden's accuracy in his book, but the accuracy is not complete: in the early chapters he frequently confuses B.E.4s and B.E.8s, and is by no means clear about R.E.5s and R.E.7s at a time when he was much more likely to have seen the R.E.4. These confusions are quite pardonable, however, for most of the book was written from memory shortly before McCudden was killed.

This might be a good time to reconsider the S.E.s built at the Factory itself, for quite a number had serial numbers outside the A range. They were as follows: *S.E.5:* A.4561—A.4563, A.4845—A.4868, A.8898—A.8947. *S.E.5a:* B.4851—B.4900, C.1051—C.1150, D.7001—D.7050.

These serial numbers represent a total of 277 aircraft, against which we must set our knowledge that 238 S.E.5s and 5as were built at the Factory. I think that the N.E.1 machines had serial numbers later than the "A" series.

Birmingham 32. J. M. BRUCE.

Rescue Helicopters

HAVING just read the interesting reports in *Flight* on the "Helicopter forum" it occurred to me that the availability of helicopters in the remote and almost inaccessible regions traversed by many air routes would be of great value in expediting the rescue of survivors of forced landings in these areas.

A possible alternative to a long-range helicopter capable of rescue operations in any part of the world would be a light helicopter which could take off from a conventional aircraft while in flight and then re-attach itself. This would enable the helicopter to be ferried to the rescue area, where it could transfer the survivors two or three at a time to the parent plane.

I realize that such a project would present considerable technical difficulties; but, if these could be overcome, the result would be an extremely valuable and versatile rescue device. Since the existence of these rescue units would benefit all nations, the expense of initiating and maintaining such a service could be met by an international fund.

Melbourne, Australia. R. THOMAS.

HIGH-ALTITUDE AIR TURBULENCE

Belfast Test Pilots' Observations Collated: Curious and Contradictory Phenomena

A VALUABLE "by-product" of Canberra flight testing by Short Bros. and Harland, Ltd., at Belfast, is a report on high-altitude air turbulence. Prepared by Eric Hyde, one of the company's test pilots, it covers a twelve-month period of flying by Short pilots in Belfast-produced Canberras and in the S.A.4 experimental jet bomber. Based on rough notes and jottings from test reports, and made purely for interest, without details of exact areas and times, the report is not claimed to be comprehensive; but the wide scope of operation and the experience involved make it interesting and instructive.

Test flights covered by the report amounted to about 300, the majority of which extended well into the stratosphere, and the turbulence reported was encountered above the highest cloud layer, or at altitudes of over 18,000ft. The general area of operations lay, roughly, between latitudes 52 deg and 58 deg N., and longitudes 2 deg and 11 deg W.

The normal requirements of test flying usually made it necessary to choose areas offering the smoothest conditions; even so, on many occasions operations were restricted, or abandoned altogether, because of the degree of turbulence encountered. This varied greatly, ranging from light, irregular buffeting, producing a marked "cobblestone" effect, to violent displacement of the aircraft, such as would be experienced in well-developed cumulo-nimbus cloud. Even in severe or violent conditions, however, vertical displacement never appeared to be more than about 50ft, although the bumps were of high frequency, applying considerable g. Occasionally the instrument panel became completely unreadable, and in a number of instances, despite visual flight conditions, control proved difficult and fatiguing. Although the aircraft was affected about all axes, the greatest effect appeared to be on directional control.

As V-g recorders were not carried, no accurate figure can be given for g values, but it is estimated that conditions in the most rigorous form produced accelerations in the order of $-1\frac{1}{2}$ g to $+5$ g; the feel of the aircraft was, in fact, very similar to that experienced in low-level flight at high indicated air speeds in very turbulent air.

The varying degrees of turbulence, says the report, may best be classified in intensity as follows: (1) *Mild:* Perceptible buffeting, producing a "cobblestone" effect, with approximately 6-8 c.p.s. oscillation. This is felt on the controls and is discernible by passengers. (2) *Light:* Pronounced "cobblestone" effect and airframe buffeting of greater amplitude. Control displacement occurs and some passenger discomfort is experienced, particularly if the effect is prolonged. (3) *Moderate:* Intermittent heavy airframe buffeting, control is uncomfortable, and the aircraft becomes unstable about all axes. In an airliner under such conditions, passengers would have to fasten safety-belts and no meals could be served. (4) *Severe:* Cumulo-nimbus conditions; appreciable g is experienced and control becomes difficult and fatiguing; extremely unpleasant for passengers. (5) *Violent:* Approximating to high-speed flight in very turbulent air at low levels, with intense bumps producing high g values. Apart from aircraft stress and control considerations, it is felt that flight in these conditions, even for short periods, would be quite unacceptable to airline passengers.

During 1953, however, only three instances of this violent turbulence were recorded—on May 23rd, October 26th and December 21st. The respective heights were 26,000-28,000ft, 22,000-23,500ft and 22,000-24,500ft. In each case the approximate area was the North Channel. A more recent instance of very severe turbulence occurred on February 20th this year, at 33,000-34,000ft over the Solway Firth.

It appears that, in severe or violent conditions, the "cobblestone" effect experienced in the lighter forms of turbulence reaches an exaggerated form, indicating that the change is quantitative rather than qualitative.

Layer Effects

Layers of turbulence may, quite simply, be divided into three brackets: (1) *Up to 30,000ft:* Apart from a few isolated examples, all severe and violent turbulence occurs in this region, the areas most affected being between 25,000 and 29,000ft. (2) *From 30,000 to 40,000ft:* Violent conditions were not encountered in this bracket, and the highest case of severe turbulence recorded was at 36,000ft. There were, however, many instances at up to 34,000ft. Above 36,000ft, no conditions exceeding the moderate were experienced, but there were numerous cases, particularly during the summer months, of moderate turbulence in the 38,000-43,000ft band. (3) *Above 40,000ft:* The highest recorded altitude at which turbulence occurred was 49,000ft, where "light" conditions were encountered over a 1,000ft band on March 17th, 1953. Two similar cases were also experienced between 44,000 and 46,000ft.

The depth of turbulent layers varies between 500 and 3,000ft, but in the majority of cases it is 1,500ft. The presence of one layer does not appear to preclude the existence of others, and on more than one occasion three distinct bands were encountered, at altitudes between 24,000 and 38,000ft, the deepest layer always lying at the lowest altitude. A very severe band, approximately 1,100ft deep, was encountered within one of moderate strength and an overall depth of some 2,700ft.

In the absence of thick haze the tropopause is often extremely well defined, and it has proved possible for the pilot to estimate its height accurately. These estimates have, on many occasions, been checked with the Meteorological Office, and even under unfavourable conditions the error has rarely exceeded 1,000ft. The method of assessment is much the same as that employed in estimating the height of the top of a haze layer, but there is the added advantage that the dark sky characteristic of the stratosphere produces a "light" band around a false horizon. To make an accurate assessment and to avoid confusion with existing haze layers, the phenomenon has to be viewed from some 500-1,000ft above, or higher if thick haze is present.

No appreciable increase in the overall incidence of turbulence could be traced to the tropopause or its immediate area. Sustained flight, however, was rarely carried out purposely at the appropriate heights, and the tropopause, unless located at certain high altitudes, was usually passed through only during climb and descent. Above the tropopause, turbulence was experienced only rarely and was seldom more

Eric Hyde, who prepared the report given in slightly abridged form on this page. He and his fellow test-pilots at Belfast collected the data whilst flying Short-built Canberras and the Short S.A.4, usually within a radius of some 200 miles from their base.

The photograph shows the PERCIVAL "PROVOST" T. Mk. 1, fully aerobatic Standard Basic Trainer in service with the R.A.F.

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HIGH-ALTITUDE AIR TURBULENCE...

than moderate. A recent exception occurred when severe conditions were encountered at 33,000ft; the forecast height of the tropopause was 30,500ft. The explanation would seem to be the penetration of a jet stream from the low-pressure side, together with an incorrect forecast; the pilot assessed the tropopause height visually as 32,500ft.

Experience, continues the report, so far indicates little association of turbulence with cloud formations or frontal systems. Many flights through and in authenticated jet streams, at all altitudes, have yielded no trace of turbulence; conversely, moderate to severe conditions have been experienced when forecast upper winds were negligible. On the frequent occasions when jet streams were reported in the flight area, the incidence of turbulence was approximately 40 per cent. In cirrus cloud, flight was invariably smooth, although severe conditions were encountered in clear air at cirrus levels with 2/8 to 3/8 cloud present; and moderate turbulence was by no means rare above 8/8 alto-stratus and/or cirrus, usually within 500 to 1,000ft of the cloud tops.

The highest cloud encountered in the Western Approaches was frontal cirrus at 36,500ft, and it was found that cloud tops of a 35,000-36,000ft frontal system in the west quite frequently increased to 38,000ft as the front passed over England. Thick haze, and what were possibly smoke layers, were encountered at heights up to 46,000ft. Varying in intensity, these layers were invisible from the ground, yet had the effect of drastically reducing visibility at altitude. Possible smoke streaks, resembling black contrails, were also observed on several occasions.

The most difficult phenomenon to explain is the nature of the turbulence itself. Despite the effects about all axes of the aircraft, the violence, and the limited vertical extent of the bumps, it does appear to have an "eddy" form, and manifests itself as a horizontal rather than a vertical force. An example quoted by Mr. Hyde occurred on January 28th this year, when very severe turbulence was encountered by two Canberras flying in close formation over the Barrow area. The bumps were violent and of high frequency, but by far the greatest effect was felt on directional control. The pilot of the second aircraft found the effect particularly noticeable, because the leading Canberra developed an exaggerated and relatively slow tail wag. The aircraft were then flying at Mach 0.75, and there was no cloud other than some distant strato-cumulus.

From these observations Mr. Hyde estimates that the incidence of all clear-air turbulence up to and including *moderate* is 28 per cent; *severe* is 7 per cent; and *violent* turbulence is 1 per cent. Local effects—particularly in areas immediately north and south of the Lake District—considerably intensify existing turbulence irrespective of its height band. It is always possible, however, for the pilot to climb or descend out of turbulent layers, a height alteration of 1,500ft usually being sufficient.

PORTENTS FOR THE VICTOR

IN every aspect of performance tested so far the Victor jet bomber has exceeded the operational requirements laid down. This claim was made recently by Sir Frederick Handley Page, chairman of Handley Page, Ltd., in his annual statement to shareholders. The requirements, he added, called for a higher performance than for the other V-bombers in current production, and the basic design promised even better performance and greater striking power.

For the efficient and economical production of the equipment required for a force of strategic bombers, Sir Frederick averred, initial planning and works organization must be laid down to cover the programme extending over the whole period of years of the aircraft's operational effectiveness. In this way, rapid and economic production would be achieved; highly efficient mechanized methods could be employed instead of the slow and expensive handwork which was necessarily associated with a policy of ordering in "penny numbers." Unit costs would be lowered and a large quick flow of aircraft to the squadrons ensured.

Sir Frederick disclosed that the company were carrying out an active research programme into the problems and possibilities of sustained supersonic flight, and that research into boundary-layer control had continued during the year. This was directed particularly towards increasing range and operational economy.

Among the duties of the Hastings transport he listed the operation of a courier service between Britain and the Woomera rocket range. The Australian Supply Minister had described this as "the lifeline of the long-range weapons project."

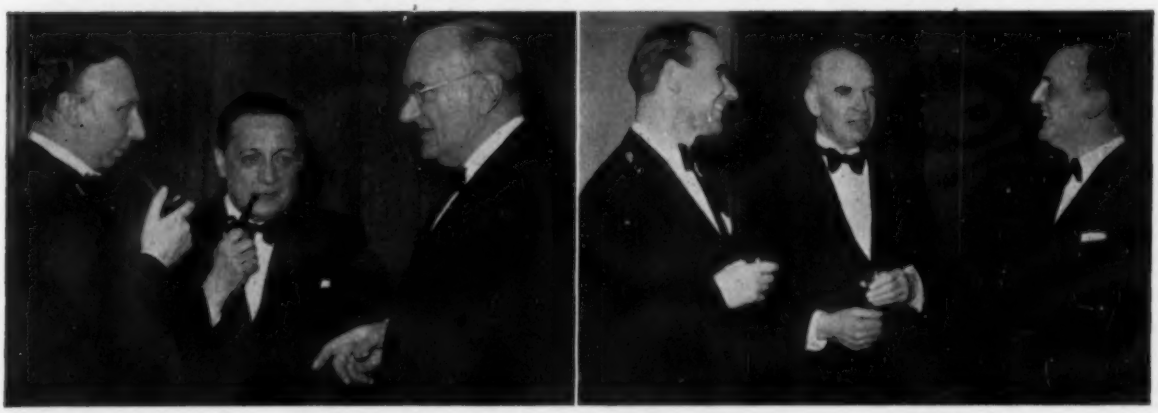
H.P. group net profit, after providing £403,831 for taxation, was £243,574, an increase of £53,646, of which £28,811 was attributable to the subsidiary company at Reading.

ENGLISH ELECTRIC FEEDERLINER

ACCORDING to a report published in America, English Electric have a project for a 32-seat medium transport. It would be powered by an Armstrong Siddeley Double Mamba, developing something over 3,500 h.p., and mounted in the nose. Although there might be some official objections to classifying such a machine as genuinely twin-engined, such an installation would show considerable saving in structure-weight in comparison with that of a conventional twin, since it would require neither the wing strength nor the fin size normally required to deal with asymmetric flight.

The aircraft will reportedly have an all-up weight of 30,000 lb and a payload of 10,000 lb, a fixed undercarriage, a cruising speed just over 200 m.p.h. and an optimum range of 600 miles. At reduced load 1,000 mile range could be attained. The cost per aircraft might be in the region of £89,000.

SCIENCE AND INDUSTRY FORGATHER AT CRANFIELD



Pictured at the sixth annual dinner of the Senior Common Room Society of the College of Aeronautics—reported in last week's issue—are (left to right): Mr. A. A. Hall, Director of R.A.E., Farnborough; Dr. O. G. Sutton, Dean of the Royal Military College of Science; Sir Frederick Handley Page; Sir Reginald Verdon Smith; Sir Frederick Mander, chairman of Bedfordshire County Council; and Mr. W. T. Gill.

(Left) Japanese convertible helicopter—the Kayaba "Heliplane." (Right) Beech 45 Mentors in service with the Japanese Garrison Force.

NEWS FROM NIPPON

ALTHOUGH somewhat startling at first sight, the peculiar machine in the photograph above has, readers may detect, a familiar-looking fuselage. The aircraft itself did, in fact, begin life as a Cessna 170B: when modification is complete, it will be the Kayaba "Heliplane," Japan's first venture in the field of convertible aircraft. Test flights are due to commence this summer.

In addition to the normal 180 h.p. Continental engine driving the nose airscrew, three Ishikawajima ramjets are to be fitted to the blade tips of the 36ft diameter rotor. The rotor ramjets, it is claimed, will make possible a vertical climb, and the machine can "cruise holizontally, as like that of autogyro, with its nose engine alone" [we quote honestly and exactly from our Tokyo correspondent's report]. The first steps towards the construction of the convertiplane were taken two years ago by Shiro Kayaba, founder and president of the Kayaba Industrial Co., which, before the last war, manufactured autogyros and aircraft landing gear.

The second photograph shows the first two Beech 45 Mentor primary trainers for the Japanese Garrison Force (formerly the Maritime Safety Force), which made their first public appearance at the Utsumoniya airfield on March 12th. About 20 of these machines are expected to be purchased from the U.S.A., and an additional 40 are to be assembled by Fuji Heavy Industries, Ltd. (formerly the Nakajima Aircraft Co.), at its Utsumoniya factory, where Oscar fighters were assembled during the war. The first batch of trainers, including the two shown, will be used by the Kanoya Air Training School of the Japanese National Safety Board; the School is scheduled to be opened within a few months to train pilots for the future Japanese Air Force.

COMFORTABLY TO THE MOON

ALTHOUGH a great deal of thought has gone into the design of rocket motors and structures for space-vessels, comparatively little has been devoted to the design of the crew's compartments and the provision of the necessities of life—although there has been an upsurge of interest in "space medicine" during the past few years. These considerations were discussed in a lecture by Mr. N. R. Nicoll, chairman of the Midlands Branch of the British Interplanetary Society, at a recent London meeting of the Society.

As a basis for a design the speaker considered a crew of three being transported from an orbit about the Earth to the Moon and back—a tour of 15 days, which allowed about seven days on the Moon. It was thought that this would approximate to the requirements of one of the initial exploratory voyages. Since the cabin would have to be brought up from Earth into an orbit as part of the top step of a multi-step rocket, it was roughly ogival [resembling a pointed arch, or the nose of a projectile] in shape and would be covered by a ceramic "carapace" which would be jettisoned after it had performed its duty of protecting the cabin from aerodynamic heating effects on the way up.

The cabin would utilize a double-wall construction with a gap of about one inch between the walls. The outer skin would be highly polished on both sides, but the inner skin would be so treated on its outer side only. The speaker had shown experimentally that by this means heat radiation could be cut to about one per cent of the value attained by the use of unpolished surfaces. The outer skin would also act as a "meteor bumper," since it had been shown that quite a thin skin was sufficient to vaporize the majority of meteors.

The whole cabin would be made to revolve at one revolution every 3.3 sec, thus producing an "artificial gravity" equivalent to 1g at the circumference of the 18ft-diameter cabin.

A coelostat, said the lecturer, would provide a stationary view of the heavens, and couches running on curved rails could be used either on the base of the cabin during take-off as acceleration couches, or against the circumference during free fall for resting purposes.

Provision of air, food and water was a most important matter but did not become a major problem for such a short journey. A person performing a moderate amount of work exhaled two pounds of carbon dioxide and one pound of water per day; these would have to be recovered and the oxygen replaced. The water could be frozen out and the carbon dioxide absorbed by a solution of lithium hydroxide—this was more efficient than soda-lime. A total oxygen replacement of 56 lb for the trip would be required. An air pressure of about half normal atmospheric pressure could be used, and this would reduce the total requirements. The water recovered could be used again in a closed cycle and the extra requirement would be very small. One pound of high-energy food would be needed per man per day.

In all, the total weight of cabin structure, instrumentation, food and air came to under one ton. In the project assessment for which this study was made, the weight allowed had been three tons. Thus, over two tons still remained for the crew, their personal necessities and the equipment that would be needed on the Moon.

AUGMENTED URGE

A SIGNIFICANT improvement in the take-off performance of the Boeing B-47 Stratojet bomber is achieved with the aid of a new external JATO arrangement and a water/alcohol injection system for the six General Electric J47 turbojets. These and other new features are standardized in the B-47E, now being delivered to the U.S.A.F. This model has a gross weight of 200,000 lb, or 15,000 lb more than earlier models.

The principal feature of interest is the new jettisonable "collar"-type rack for the JATO bottles; this is mounted beneath the fuselage, as shown in the picture on p. 474 and has positions for 33 bottles of 1,000 lb thrust each. Formerly 18 bottles only were carried, in a built-in rear-fuselage installation. Additional equipment is carried in the compartments formerly occupied by the JATO units. Only under extreme conditions will both the water/alcohol and JATO systems be used simultaneously.

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The fitting of hydraulic servo-controls—a unique feature of the Westland S51 and S55 Helicopters—has removed much of the tedium of pilotage. Coupled with the all-metal blade system, they are but typical of the technical advances introduced by Westlands in the S51 and S55 Helicopters which now have well over half a million operational hours to their credit.

WESTLAND S·51 & S·55 HELICOPTERS

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CIVIL AVIATION

ROYAL SKYMASTER: Shown arriving at Essendon Airport, Melbourne, is VH-INZ "Laxapana," the Australian National Airways DC-4 in which H.M. The Queen flew from Launceston.

A NEW STRATOLINER

STRATOLINER is the name chosen by the Boeing Airplane Company for the civil version of the prototype jet tanker/transport now under construction at Renton, Washington. The military refuelling version will be known as the Stratotanker. Unofficially referred to as the Boeing 707 or, more dramatically, as "Project X," the aircraft is in fact officially designated Model 367-80.

The original Stratoliner was the Boeing Model 307, of which a few examples are still in service. When it entered service early in 1940 with PanAm and T.W.A. this four-engined 33-seater was one of the most advanced airliners in the world, employing the first pressurized cabin. Wings, engines and tail unit were basically those of the B-17 Flying Fortress. Like its distinguished ancestor, the new Stratoliner embodies experience gained in the design and operation of bombers—in this case the B-47 and B-52. The prototype, intended for test and demonstration, is due to fly in June.

Some stages in the evolution of the Stratoliner/Stratotanker design, reported to have involved 21,000 hr of wind-tunnel research, are illustrated below. Design-studies considered by the company before construction of the prototype began in 1952 included the Model 367-60 (1950), a gull-winged turboprop version of the C-97 Stratofreighter. The Model 367-64 (1951) retained the double-bubble fuselage but was to be powered by four turbojets. Finally, in 1952, came the 367-80, with re-disposed pods, oval-section fuselage and increased sweep-back (35 instead of 25 deg), permitting a thicker wing and increased fuel capacity.

DC-7 PROGRESS

WRITING from New York, *Flight's* Editor reported recently that American Airlines have taken delivery of 18 of their 25 DC-7s, and that completion of the order is expected by June this year. He added: "I was very impressed with the plain but tasteful interior—roomy, with comfortable seats and fawn trimmings in real hide." American are pleased with the DC-7's performance, and have encountered relatively few teething troubles. Pilots like the "speed-brake" undercarriage, which can be dropped by gravity, unlocked, at any speed up to 300 m.p.h. and allows a 5,000 ft/min descent.

DC-7s in service with A.A. are flown by three-man crews—two pilots and an engineer. At present the engineer occupies a small folding seat between and just behind the pilot, but a modification now in hand will provide an improved engineer's station behind the co-pilot's seat.

The original proposal for a lengthened, compound-engined version of the DC-6B was put forward by American Airlines three years ago. Douglas completed design work in October 1952 and the wings and tail of the first aircraft were joined in February 1953. The first flight was made on May 18th, and the C.A.A. flight-testing programme began on July 22nd.

Although the DC-7 is faster and more capacious than its predecessor, the DC-6B, the degree of similarity between the two made construction of a DC-7 prototype unnecessary. Airworthiness trials, involving 204 separate flights, were performed with three production models. Deliveries went on concurrently with testing, so that the final certification of the DC-7 and its inauguration on coast-to-coast services by American Airlines took place simultaneously on November 30th.

Altogether 88 DC-7s have now been ordered by seven airlines. The latest order, placed by P.A.W.A., was for seven "overwater" versions sub-designated DC-7B. Deliveries, which totalled 30 aircraft on March 29th, have been made to three airlines—American, National, and United.

A number of new American domestic speed records, officially observed by the National Aeronautics Association, have recently been set up by DC-7s. On Monday, April 5th, one of A.A.'s new aircraft, carrying 60 passengers on a normal scheduled service, covered the 2,468-mile journey from Los Angeles to New York in 6 hr 10 min; the average ground-speed was thus 400 m.p.h. The following day American Airlines broke their own record when another DC-7 (also carrying a full load of 60 passengers) completed the journey at 420 m.p.h. in 5 hr 51 min.

A TUDOR INCIDENT

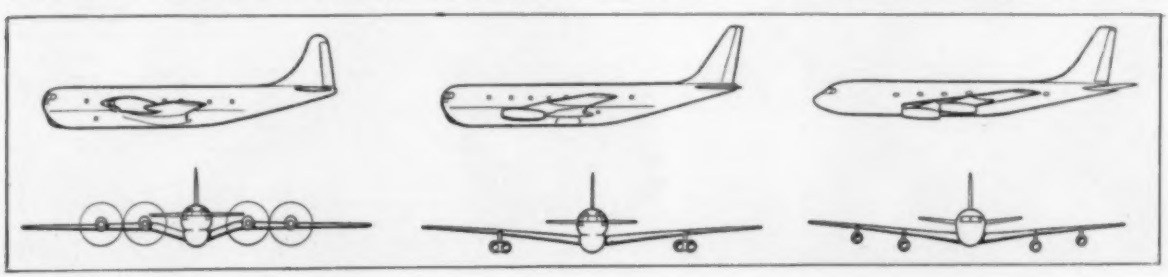
DURING a cargo flight from the United Kingdom to Malta on March 2nd, Tudor 1 G-AGRI, owned by Aviation Traders, Ltd., stalled in cloud at 9,500ft over France. Full control was not regained until the aircraft had reached 2,500ft, and the pull-out process caused some damage to the skinning. Pending completion of M.T.C.A. investigations, the precise cause of the incident has not been disclosed. However, A. V. Roe, Ltd., have stated: ". . . the aircraft was flying on automatic pilot at a low speed which did not cover for sudden changes in weather . . . a minor change in operating technique is sufficient to obviate any recurrence. . . ."

LOCAL-SERVICE HELICOPTER

THE first of America's local-service carriers to operate a helicopter will be Mohawk Airlines, who expect to take delivery of an eight-seat Sikorsky S-55 on April 26th. Mohawk at present operate ten 26-seat DC-3s on local routes in New York State. Last summer the company announced its intention of replacing the DC-3s with 35-seat twin-engined helicopters. Initial cost of the S-55 is quoted as $150,000 (£53,000).

Mohawk's president, Mr. Robert E. Peach, describes its pur-

JET-TRANSPORT EVOLUTION: Three Boeing design-studies referred to above: (left to right) Models 367-60, 367-64 and—due to fly shortly—367-80.



HIGH ASPECT: Two Miles Aerovans (span 50ft) provide contrast in this aerial view of the slenderly winged Hurel-Dubois H.D.31 during its recent visit to Shoreham; also in the picture is the Miles Sparrowjet. Both the H.D.31 and the more powerful production version, H.D.32, have a span of 147ft 7in. (Left) The H.D.31 is seen approaching to land at Shoreham.

CIVIL AVIATION . . .

chase as "the most significant step thus far taken by any local-service airline towards complete independence from Government mail-pay support." He added that his company has a lower mail-pay need than any of the other 13 local lines. Last year Mohawk received $1m subsidy payment, of which $400,000 went back to the Government in fuel and other taxes; landing fees accounted for a further $100,000.

AER LINGUS VISCOUNTS

A RECENT passenger aboard one of the two Viscounts in service with Aer Lingus was the President of the Republic of Ireland, Mr. Sean T. O'Kelly. His Excellency, accompanied by his wife, flew for about three hours, covering 750 miles. During the flight Mr. O'Kelly took over the controls and made two circuits of Galway City at a height of 1,000ft.

The first scheduled flight by one of the 48-seat Irish Viscounts was made between London and Dublin on April 5th. By May 25th they will be operating all day flights between the two capitals. Use of Viscounts reduces the published time for this 280-mile route from 2 hr (DC-3) to 1 hr 20 min.

DECTRA AND DELRAC

AS briefly recorded in *Flight* last week, two long-range radio navigation aids proposed by the Decca Navigator Co., Ltd., were submitted by the United Kingdom delegation to the recent I.C.A.O. Communications Division session in Montreal. The Division has now recommended that I.C.A.O. should encourage member states to continue the development and evaluation of these aids, together with an American-sponsored system known as Navaglobe/Navarho. Few details of the latter have yet become available, but its functions are similar to those fulfilled by Delrac.

Dectra is intended to provide a navigational aid over specific air routes such as desert and ocean stages, and is based largely on existing Decca techniques. Because of this affinity with Decca systems already in operation, Dectra should be ready for use in the near future. Providing an accuracy closer than five miles throughout a route-length of 1,600 to 1,800 miles, the system makes use of master/slave pairs of transmitting stations, which, situated at the ends of a route, provide tracking and ranging information through an airborne receiver similar to the normal Decca set. Transmitting frequencies are in the Decca band, 70 to 130 kc, and the information can be presented pictorially on the Decca Flight Log.

Delrac, as its name implies, is a long-range area-coverage system for high-accuracy position-fixing for ships and aircraft all over the world. Very low frequencies, suitable for long ranges, are employed, and the ground stations are arranged in master/slave pairs, each providing a hyperbolic position line. Presentation is either by meter or by Decca Flight Log. Each pair of stations has a predicted range of 3,000 miles, and an accuracy of ten miles or better is expected. Operating on the V.L.F. navigation-aid band of 10 to 14 kc, 21 pairs of Delrac stations are considered more than sufficient to provide complete world coverage.

The Decca Company claims that Delrac will combine in the one system the high accuracy of continuous-wave hyperbolic technique with the reliability of a virtually unambiguous fix. This system is reported to be still under development, but it is claimed that it could be put into operation within two years.

SABENA APPOINTMENT: Mr. Paul Stouffs, who is remembered in London as a special representative for Sabena, has been appointed commercial manager. He succeeds Mr. Schoevaerts, whose death is reported on this page.

BREVITIES

SPEAKING before a Canadian House of Commons committee on April 1st, Mr. Gordon McGregor, president of T.C.A., said that his company had so far made no plans for using jet airliners. They had been unable to satisfy themselves that turbojet aircraft could be operated commercially on T.C.A.'s routes.

* * *

The death occurred in Brussels on April 1st of one of the pioneers of Belgian civil aviation, Mr. Léon Schoevaerts, commercial manager of Sabena until a few days before his death. Mr. Schoevaerts, who joined the airline in 1929, played an important part in the development of the first service between Brussels and Leopoldville in 1935, and in the establishment of the internal services in the Congo.

* * *

Public enclosures at British state-owned airports, which attracted 826,000 visitors last year, are now in the process of reopening for the summer season. The enclosure at Birmingham was opened on April 5th, followed on April 15th by those at London, Northolt and Croydon. Enclosures at Blackpool and Liverpool are due to open today and the Prestwick public enclosure will reopen on April 20th. Pleasure flights can be made at London, Northolt, Prestwick, Blackpool and Birmingham.

* * *

A small but extremely active subsidiary of Airwork, Ltd., is Straits Air Freight Express, Ltd., which operates two Bristol 170s between the North and South Islands of New Zealand. The company achieved some notable results in 1953: although the average stage flown was only 98.5 miles, the Freighters flew 1.9m ton-miles at an average load factor of 78 per cent. Cargoes carried included racehorses, cattle, sheep, fruit and 700 cars. Recently one Freighter lifted 110 tons across the Cook Straits in a single day.

Delivery of T.C.A.'s fleet of eight Super Constellations is expected to be completed by September 4th. The first of these aircraft was handed over on February 23rd and flown to Dorval ten days later, after a period of crew-training at Burbank.

* * *

An American company is reported to have applied to the C.A.B. for permission to operate a commercial air refuelling service. Refuelling areas proposed by the company—the United Nations Aviation Corporation—include Shannon, Bermuda, the Azores and Alaska.

* * *

Air Charter, Ltd., report that Tudor 4B G-AHNM, in service on the minor airlift between Berlin and Hamburg, is regularly carrying over nine tons of general freight on this comparatively short (163-mile) route. The aircraft is taken off at some 5,000 lb below its permitted all-up weight of 82,000 lb.

* * *

Philippine Air Lines have announced the suspension of their long-range services to Europe, Japan and America. In addition to the domestic services operated with DC-3s and Convairs, P.A.L. will maintain their overseas routes to Hongkong, Bangkok and Taipei. The DC-6Bs and DC-6s formerly used on the long-haul international services are being offered for sale.

* * *

Following two months of discussions in Djakarta, Indonesia, it has been agreed that the Indonesian Government will purchase K.L.M.'s 50 per cent holding in Garuda Indonesian Airways. Although the Dutch airline will hand over the management, it will continue to provide Garuda with technical assistance until 1960.

* * *

Although 1953 was a record year for T.W.A. (the company carried 3,140,000 passengers compared with 2,573,000 in 1952, and earned £67m as against £57m), the airline's net income, after provision for taxes, dropped from £2.75m in 1952 to £1.8m last year. Two reasons for this reduced profit are given in the company's annual report: (a) £2,321,000 increase in depreciation charges, resulting from additions to the T.W.A. fleet; and (b) the continuation of temporary mail rates applying to international services, which incurred a net loss of £54,360.

FOR AUSTRALIA: Among the Viscounts in production at Vickers-Armstrong's Hurn factory are six Series 720s for Trans-Australia Airlines; the first, of which the fuselage shell has lately been completed, is due for delivery in June.

* * *

There were 3,513 take-offs and landings by transport aircraft at London Airport during February, a 43 per cent increase over the movements in February 1953, and the number of passengers handled rose by 47 per cent to 73,300. Northolt's movements and passenger totals dropped by 48 per cent and 47 per cent respectively, but the overall result for the two airports combined was a 9 per cent increase in the total number of passengers (91,600). The total number of air transport movements at all U.K. airports for the month was 10,700 (3 per cent increase) and the total for passengers was 159,000, 11 per cent more than in February 1953.

CLUB AND GLIDING NEWS

ELSTREE Flying Club intend to form a competition team for spot landing and other contests this season: both home and away competitions are envisaged. Between April and September, also, six individual contests will be held at Elstree in navigation, airmanship, spot landing and other aspects of club flying in order to decide (and we quote C.F.I. David Ogilvy in his most recent newsletter) "Elstree's summer champion for 1954 and our most respected member."

GLIDING courses announced by the Midland Gliding Club at the Long Mynd this summer are from May 29th-June 5th, July 3rd-10th, August 7th-14th, and August 28th-September 4th, all dates inclusive. They are intended mainly for glider pilots with "C" certificates and for qualified power pilots, but a limited number with "B" certificates will be accepted on each course, and a small number without previous flying experience may be admitted. Two T.21Bs, two Tutors, one Prefect, one Kite 1 and two Olympias will be used. Enquiries should be addressed to the secretary of the Midland Gliding Club, Mr. S. H. Jones, at 9, Hagley Road West, Harborne, Birmingham 17.

RECENTLY produced by OSTIV (*Organisation Scientifique et Technique Internationale du Vol a Voile*) is the organization's second publication, consisting of the technical papers presented at the fourth congress at Madrid in 1952. Complementary to the American Meteorological Society's monograph which comprised the meteorological papers given at that meeting, the new publication contains the remainder of the papers, which concern the design, aerodynamic, performance, equipment, airworthiness, medical and economic aspects of gliding. These include a discussion on boundary-layer control on sailplanes by Dr. August Raspet (U.S.A.), a summary of two-seat sailplane designs by Beverley Shenstone.

This book, a most useful guide to many aspects of present-day gliding research, can be obtained from the OSTIV secretary at 3 Kanaalweg, The Hague, Holland, price 3.80 Dutch guilders.

VARIATIONS ON A THEME: British and German hopes for this year's international gliding contests both centre on two-seat, vee-tail designs. (Left) The German HKS 1, to be flown by Hanna Reitsch and Erika Leutloff in the two-seat class, and by Ernst Günther Haase in the single-seat class. (Right) The British K.1, to be flown by Philip Wills, and here seen at Lasham with the designer, Hugh Kendall, at the controls.

PRODUCTION INFORMATION DISCUSSED

Interchange of Technical News: I.P.E. and ASLIB Conference at Cranfield

SIXTY delegates attended the joint conference of the Institution of Production Engineers and the ASLIB Aeronautical and Engineering Groups at the College of Aeronautics, Cranfield, from April 2nd-5th. The general subject was "Production Information" and, at the opening session, papers were presented by Mr. W. E. Goff, editor of *Aircraft Production* and Mr. Saunders, chief work-study engineer of the Glacier Metal Co., Ltd.: Mr. F. B. Roberts, editor of *Engineering*, was in the chair.

Discussion centred on the various aspects of the problem involved in recording and distributing information on production processes and techniques. It was agreed that there was great difficulty in persuading production engineers to write reports or articles in the first place, either because of the time involved or because of a reluctance to reveal anything which might benefit a commercial rival. From the editorial viewpoint, most of the material that was made available needed very thorough revision to put it into a form suitable for publication.

It was suggested that the problems were interrelated, and that more engineers would be willing to write about new developments if it were known that they would not be expected to reach the high standard required for publication in a journal or presentation at a meeting of a learned society.

If a central organization were willing to accept unpublished reports, prepare title lists for general distribution and lend copies to those who wished to see them, a great deal of useful information would be available. Some doubts were expressed as to whether the published article could ever be so useful as the personal contact; but the main emphasis in this and the subsequent session was the importance of improved training in information methods for the production engineer.

Professor J. V. Connolly, Head of the Department of Aircraft Economics and Production at the College of Aeronautics, was in the Chair when the meeting discussed the exploitation of published information. Mr. D. Seaman, general manager of the British Oxygen Engineering Co., Ltd., emphasized the importance of an integrated information policy throughout a firm. The purpose of any system of information was to attack a particular objective and it was absolutely vital that all the people in the organization should have their minds attuned to the particular target. He suggested that ASLIB should make a practical research study of the mode of control of various types of production units.

Mr. P. Spear, research director of Rubery Owen and Co., Ltd., concentrated on the problems of the production engineer in a medium-sized organization. The production engineer was a specialist in "not being a specialist," or a specialist in the art of using other specialists. He would obtain his information from many places, and it would concern many different things. The librarian must have a wide experience, with a full knowledge of the sources of information, but it was most important that he should have full co-operation.

The discussion showed that there was general recognition that the outlook of the production engineer towards information was gradually changing as more trained men came to the profession. The suggestion was made that the professional institutions might include in their examinations a question on available sources of information.

It was announced that ASLIB and the Department of Scientific and Industrial Research were at present considering the possibility of running short courses intended to broaden liaison engineers' knowledge of the ways of obtaining information from sources outside their own organizations.

While the production engineers at the conference visited the Department of Aircraft Economics and Production, and the Work Study School, the librarians had a final session to discuss the various points which had arisen at meetings.

Though the proceedings of the conference tended at times to wander away from the specific subject—as is almost inevitable at meetings of this kind—it was generally agreed that the exchange of views was likely to prove beneficial; and in any case the event provided a useful opportunity for people with mutual interests to meet one another.

FLIGHT REFUELLING AND ZENITH

AS briefly announced in *Flight* last week, French manufacturing and sales rights for the range of aircraft fuel system components designed and produced by Flight Refuelling, Ltd., have been granted to Société Carburateur Zenith. The agreement, for an initial period of ten years, gives the Zenith company the sole manufacturing licence for Flight Refuelling's products in France. They will be manufactured at the French company's factories at Lyons and marketed under the combined trade name of Zenith-F.R. The agreement does not include equipment for refuelling aircraft in flight.

Mr. Christopher Tonge, F.R. director and general manager, states that the decision has been taken for two reasons: to meet the increasing demands of the French aircraft industry for the British company's fuel system components; and to comply with the French Government's policy of restricting imports of articles that could be manufactured in France.

For the past five years Flight Refuelling, Ltd., have been represented in France by M. Costa de Beauregard, an engineer widely known in aviation on the Continent. Under the new agreement he will act as consultant to both companies in regard to components and ancillary equipment for the French industry, whilst continuing to act as sole agent in France for other activities of Flight Refuelling, Ltd.

F.R. components have been ordered for production models of a number of French military and civil aircraft; among them are the Vautour, Baroudeur, Caravelle and Hurel-Dubois H.D.45.

This is the first time that Flight Refuelling, of which Sir Alan Cobham is chairman and managing director, have granted manufacturing rights for their products outside the U.K. and U.S.A. Hitherto, overseas orders have been met by the normal output from the company's factories at Tarrant Rushton. Independent production in France will do much to speed deliveries to France's expanding aircraft industry; it will also leave F.R. with greater production capacity to meet the needs of British manufacturers—needs which have increased considerably since the recent mandatory requirement for the equipment of all British military and large civil transport aircraft with a system enabling them to be pressure-fuelled. An article explaining and illustrating the construction and the operation of this equipment appeared in *Flight* of February 5th.

COMPASS-SWINGING IN A NEW LIGHT

LIKE other processes involved in the servicing of modern, high-utilization aircraft, compass-swinging often has to be carried out at night. A difficulty that arises in this connection has been the reading of the landing compass in the dark, so compass adjusters will welcome news of a new lighting attachment, designed by Kelvin and Hughes, Ltd. (New North Road, Barkingside, Essex), for fitting to their medium landing compass.

Manufactured of brass, and therefore non-magnetic, the attachment fits over the verge-ring and, when switched on, beams light on to the sighting vane, compass card and bubble level in such a manner that stray light is completely eliminated. The light-source is a three-volt "peanut" bulb under-run at 1½ volts from one cell of a "pencil" battery; the continuous life of the battery is approximately half an hour. The screw cap of the battery compartment forms the switch.

When not in use the attachment is stowed in the lid of the carrying case. Provision is also made in the case to stow two spare batteries and three spare bulbs. No structural changes are required to accommodate the attachment on the medium landing compass.

The Kelvin Hughes attachment as fitted to the medium landing compass. The tube on the left transmits light to the bubble level.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

The Queen at El Adem

THE Queen's Colour of the Royal Air Force Regiment, presented by Her Majesty in March last, will be paraded for the first time overseas with the Royal guard of honour which will receive the Queen and the Duke of Edinburgh when they arrive on May 1st at El Adem, the R.A.F.'s desert staging post 18 miles from Tobruk.

The guard of honour, commanded by F/L. T. G. Wilmer, will be drawn from all Royal Air Force Regiment squadrons in the Canal Zone. Her Majesty is Air Commodore-in-Chief of the R.A.F. Regiment, whose Colour is unique in that it is the only R.A.F. Queen's Colour which may leave the United Kingdom. As the aircraft taxies to a standstill after its flight from Entebbe, Uganda, a hollow square will be formed by officers and airmen of El Adem, within which will stand the guard of honour, and the band from R.A.F. Station Kabrit, Canal Zone.

The station commander, W/C. D. M. H. Craven, O.B.E., D.F.C., and the Minister to Libya, Sir Alec Kirkbride, will welcome the royal party.

Presented to the Queen will be a Minister representing the Libyan Government, the A.O.C. No. 205 Group, A.V-M. H. V. Satterly, C.B., C.B.E., D.F.C. (who will also represent the Commander-in-Chief, Middle East Air Force, Air Marshal C. B. R. Pelly, K.C.B., C.B.E., M.C.) and General Sir Charles Keightley, G.C.B., K.B.E., D.S.O., Commander-in-Chief, Middle East Land Forces.

After inspecting the guard of honour, the Queen will take breakfast in the Movement Section's transit mess, following which Royal Air Force and British Army officers will be presented to her. Her Majesty and the Duke will then drive out of the station between ranks of airmen lining the route, on to the highway and across the desert to visit the Imperial War Graves Cemetery five miles from Tobruk, where are buried British and Commonwealth Army and Air Force men who died in the Western Desert campaigns. Later, in Tobruk itself, the Queen will meet King Idris of Libya. The royal yacht *Britannia* will begin the voyage to Malta in the early afternoon.

R.A.F. Appointments

FOUR appointments in the rank of Air Vice-Marshal have been announced by the Air Ministry. They are: A.V-M. G. W. Tuttle, C.B., O.B.E., D.F.C., to be A.O.C. No. 19 Group, Coastal Command, from August next; A.V-M. H. V. Satterly, C.B., C.B.E., D.F.C., to be Assistant Chief of the Air Staff (Operational Requirements) at the Air Ministry, from July; A.V-M. D. H. F. Barnett, C.B.E., D.F.C., to be A.O.C. No. 205 Group, M.E.A.F., from May; and A.V-M. N. S. Allinson, C.B., to be A.O.A. Flying Training Command H.Q., from June.

A.V-M. Tuttle has been Assistant Chief of the Air Staff (Operational Requirements) since September 1951, when he returned from special duties in the U.S.A. Formerly he was A.O.A. at Coastal Command H.Q.

A.V-M. Satterly, who succeeds A.V-M. Tuttle, has been A.O.C. No. 205 Group for the past two years and was, before that, Director of Operational Requirements (A) at the Air Ministry.

A.V-M. Barnett, who in turn succeeds A.V-M. Satterly, has, since October 1952, been Senior British Liaison Officer at the United Nations military headquarters in Japan.

A.V-M. Allinson has spent the last three years at the Air Ministry, first as Director of Manning and later as Director-General of Personnel (1). Succeeding A.V-M. Allinson as Director-General of Personnel (1) is A. Cdre. L. T. Pankhurst, C.B.E.; he will assume the acting rank of Air Vice-Marshal. A.V-M. Pankhurst has already spent a year at the Air Ministry as Director of Postings.

Other appointments recently announced include those of G/C. J. C. Millar, D.S.O., to Bomber Command H.Q., as Chief Signals Officer; G/C. S. L. Blunt and W/C. R. V. Fiddick to the department of the Air Member for Supply and Organization, and G/C. G. F. Alexander, O.B.E., to the Ministry of Supply. W/C. A. J. French, D.F.C., A.F.C., and W/C. E. V. Stokes are both in the department of the Chief of the Air Staff and W/C. C. D. North-Lewis, D.S.O., D.F.C., has gone to AAFCE.

For administrative duties G/C. W. K. Le May, C.B.E., and W/C. D. I. Fairburn, D.F.C., have gone to Home Command H.Q.; W/C. R. I. Alexander to Kirton-in-Lindsey; W/C. H. A. F. Summers, M.B.E., to the Record Office. W/C. F. F. Addington, D.F.C., to Stradishall and W/C. H. A. Chater, A.F.C., to Kai Tak (Hong Kong).

(To be continued)

Getting the C.O.'s Goat

NO. 1 R.C.A.F. FIGHTER WING at North Luffenham are trying a new method calculated to reduce flying accidents. A goat is involved. Once a month the statistics for aircraft accidents are studied, and the squadron with the worst accident record is ceremonially awarded a live and very un-military goat. The pilot committing the worst flying error is given custody of the animal, with full military honours at a Station parade.

The hapless pilot who wins the goat for the month must personally make sure that it is properly fed and quartered, a duty which effectively eliminates week-end leave passes.

The ambition of the station commander, G/C. J. D. Somerville, D.S.O., D.F.C., is to be left with the goat on his hands at the end of the month, and no accidents to worry about.

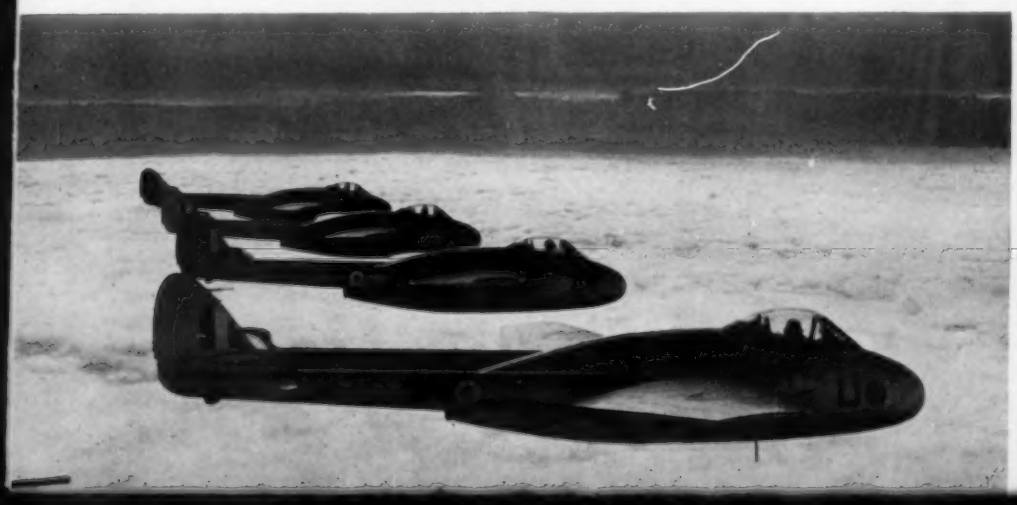
R.N.V.R. TROPHY: The new Kemsley Flying Trophy for competition between R.N.V.R. Air Squadrons. It was handed to the first winners, No. 1831 Squadron, at a ceremony aboard H.M.S. "President" in London last week.

R.Aux.A.F. Regt. Appointment

THE Air Ministry announces the appointment of S/L. T. C. Iveson, D.F.C., R. Aux. A.F. Regt., to command No. 2609 (West Riding) Light Anti-Aircraft Squadron, R.Aux.A.F., located at R.A.F. Yeadon, Leeds.

S/L. Iveson enlisted in the R.A.F.V.R. in 1938 and, in August 1941, went to Southern Rhodesia to join No. 27 Elementary Flying Training School as a flying instructor. Returning to the United Kingdom he first joined No. 14 Advanced Flying Unit and then No. 14 Operational Training Unit. In July the following year he was posted to No. 617 ("Dam-buster") Squadron for flying duties.

It was while he was with No. 617 that he was awarded the D.F.C., after completing numerous sorties on his second tour of operational duty, including three



QUEEN'S OWN: Vampire 5 fighter/bombers of No. 603 (City of Edinburgh) Squadron, R.Aux.A.F., perform a creditable line-abreast between cloud layers. The Queen is Honorary Air Commodore of the squadron, whose history we hope to publish in the near future.

SERVICE AVIATION . . .

attacks on the battleship *Tirpitz*. The citation to his award recorded that in January 1945, he was detailed to attack the U-boat pens in Bergen and that while over the target his aircraft was attacked by two fighters: "The first burst of machine-gun fire from the enemy aircraft struck the tailplane, rudder and elevator. The port inner engine was set on fire and the rear turret put out of action. After the fighters broke off their attack S/L. Iveson's aircraft came under heavy fire from the anti-aircraft batteries. It was almost impossible to maintain level flight."

S/L. Iveson then instructed another member of the crew to lash the control column in such a way as to ease the strain; and under these most trying conditions he flew clear of the fire zone and afterwards reached a home-based airfield, where he landed his seriously-damaged aircraft safely.

Iraq Flood Relief

THE extent of supplies air-lifted from British Service stocks in the Canal Zone to Iraq to assist in the fight against the recent floods near Baghdad, and to help relieve flood victims, had by April 6th amounted to 200,000 sandbags and 830 tents. A further 150,000 sandbags and 1,179 tents were then still to be lifted by R.A.F. Hastings to complete the Services' commitment. In addition, the R.A.F. in Iraq supplied 300,000 sandbags from their own resources; and when the R.A.F. completed its air-lift the British Services in the Middle East had supplied the Iraqis with over 200 tons of relief materials.

The air-lift of sandbags and other supplies from Egypt to Iraq was carried out by twin-engined Valettas of the M.E.A.F. Transport Force, and four-engined Hastings of R.A.F. Transport Command, flying the 700 miles across the Sinai Desert, Jordan, and the Syrian Desert to the Iraq capital.

The floods began when the usual rise of the Tigris at this time of year, caused by melting snows in Persia and Turkey, was aggravated by exceptionally heavy rains for 12 hours in the Baghdad area, the heaviest since rainfall records were first kept. This swelled the Tigris, and the nearby Diyala River, causing the former, which flows through Baghdad, to rise to within inches of the top of the bunds, some of which are 15 feet high.

Foreseeing the danger to Baghdad, Air Headquarters Iraq, at Habbaniya, 50 miles from the capital, telephoned the Iraqi Ministry of Defence offering any assistance the R.A.F. could give, in the name of the A.O.C., Iraq Command, A.V-M. J. G. Hawtrey, C.B.E. Men of the R.A.F. Iraq Levies were ordered to stand by, with vehicles ready to rush supplies by road to Baghdad. At first the Iraqi Government felt that help was not required, but as the Tigris rose Habbaniya was telephoned very early on March 29th, requesting that sandbags be sent quickly, in as large quantities as possible, to help bolster the bunds and close minor breaches. Immediately A.V-M. Hawtrey ordered 100,000 sandbags to be despatched by air, since at the time the condition of the desert road to Baghdad was uncertain. The crews of two Valettas then at Habbaniya were alerted to start the air-lift. One of them, consisting of F/O. G. J. Skermer, F/O. J. A. Nimmo and M.Plt. Graydon, flew eight sorties to Baghdad, between 1030 hr and 1900 hr that day.

R.A.F. Rowing Activities

WITH the Royal Air Force Rowing Club from Wallingford, Berks, off to a flying start in 1954, having scored victories in the Reading and Putney head-of-the-river races, news that the 90 Group (R.A.F.) Rowing Club have entered a coxed clinker four in the Avon head-of-the-river events at Evesham on Easter Monday suggests that rowing is again on the up-grade in the R.A.F.

The 90 Group Club, whose oarsmen have all been accepted as full members of Marlow Rowing Club, on the Thames, expect a busy season. They hope to enter a four in the several Thames Regattas, leading up to Royal Henley, where a 90 Group four may well be seen in the Wyfold Cup. This the R.A.F. Rowing Club won last season to secure its sensational Henley "double" after winning the Thames Cup.

The rejuvenation of the Group Rowing Club is due in no small measure to the energy of its coach, S/L. G. J. Henry, who some 25 years ago rowed No. 3 for Strasbourg University and the University of North Wales.

The 90 Group four will not be the only R.A.F. representatives on the Avon on April 19th, for the R.A.F. Benson Rowing Club is entered in the eights contest.

A.O.P. Trophy Presented

AS his first duty since becoming the Honorary Air Commodore of 663 Air Observation Post Squadron, R.Aux.A.F. Viscount Leverhulme, the Lord Lieutenant of Cheshire, presented the Air O.P. Efficiency Trophy to the unit at Hooton Park on April 4th.

This was the third year in succession in which the Squadron has won the trophy and this time a small replica was also presented for permanent keeping.

Addressing the Royal Artillery and R.A.F. personnel of the Squadron, Lord Leverhulme referred to the fine spirit of teamwork amongst the officers and men of both services, regular and auxiliary.

During the presentation, Meteors of Nos. 610 and 611 Squadrons, which are also stationed at Hooton Park, carried out a fly-past and salute, and Capt. John Gooding, R.A., put up an impressive, if bumpy, display of low and slow flying in violently gusty weather in an Auster 6.

The parade was the last ceremonial to be handled by 663 Squadron's adjutant, F/L. E. Dodd, who is retiring after 40 years' service. F/L. Dodd has seen most aspects of Air O.P. work during his service—his first flying tour was as an R.F.C. balloon observer in 1917.

Reunion

OFFICERS of No. 70 O.T.U., R.A.F., M.E.F. (Nakuru and Shandur) are holding a reunion at 6.30 p.m. on Saturday, April 24th, at the Phoenix Hotel, Princes Street, Oxford Circus, London, W.1. Particulars from R. E. Hall, 23, Oakhurst Road, West Ewell, Surrey (Ewell 7111).

PASSING-OUT PARADE: On April 6th the passing-out parade of the 61st Entry to the R.A.F. College took place at Cranwell. The reviewing officer was Field Marshal Sir John Harding, G.C.B., C.B.E., D.S.O., M.C., Chief of the Imperial General Staff, who is seen below inspecting the cadets. On the right are two prize winners, F/Cdt. Sen. U/Off. R. S. Blockey (Sword of Honour) and Sen. F/Cdt. R. L. Holmes (Queen's Medal). The photograph on the left shows the Colour and senior entry marching off parade to the strains of "Auld Lang Syne."

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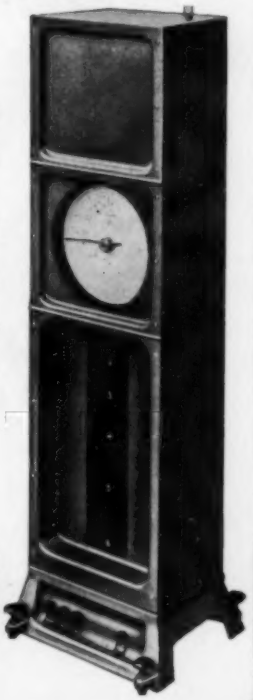

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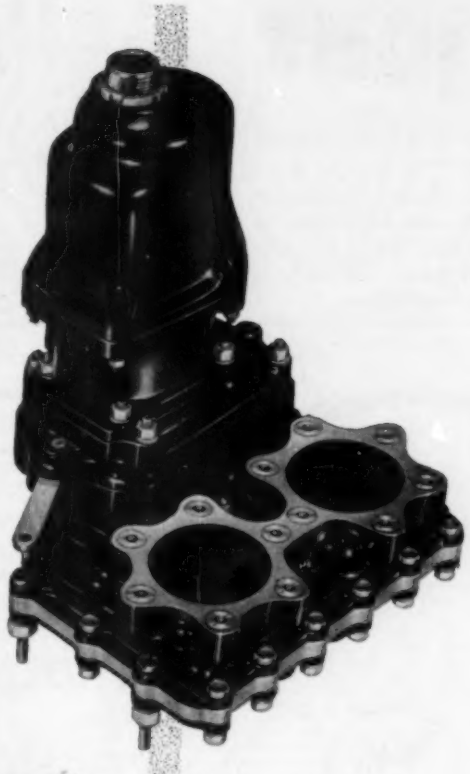

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SPECIFICATION

OPERATING CONDITIONS	*Ambient air temperature*	*–70° to 150° C.*
	Through air temperature	*350° C. (max.)*
	Through air pressure	*75 p.s.i. (max.)*
	Operating time on load	*15 seconds (nominal)*
	Pressure drop across valve	*3" WG at 100 c.f.m.* *24.3 WG at 300 c.f.m.*
	Maximum leak figure (valve closed at 75 p.s.i.)	*0.35 c.f.m.*
ELECTRICAL DATA	*Connection*	*6 pin Breeze Plug Plessey CZ48995*
	Voltage	*21–29 volts D.C. (24 volts nominal)*
DIMENSIONS	*Length*	*10.1 inches*
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	Width	*6.25 inches*
	Bore	*2 inches*
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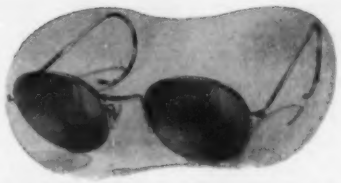

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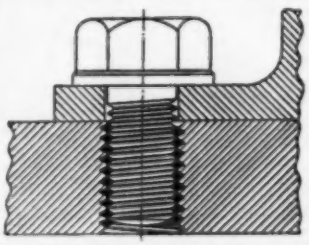

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PATENTS

THE Office National d'Etudes et de Recherches Aeronautiques, 55 Boulevard Malesherbes in Paris (France), holder of British Patents No. 673,629 dated June 11th, 1952: "Improvements relating to supersonic combustion," No. 674,854 dated July 2nd, 1952: "Improvements in jet propulsion plants, in particular for aircraft" and No. 675,994 dated July 23rd, 1952: "Improvements in or relating to aircraft wings," would like to deal with constructors in Great Britain through licensing. [1898

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FAIRCHILD cameras K24, K20, K19, K8A-B, brand new.—E.W.S. Co., 69 Church Road, Moseley, Birmingham. [1752

PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:—

Application No. 288. From Air Charter Ltd., of 15 Great Cumberland Place, London, W.1. For a Vehicle Ferry service with Bristol 170 aircraft for the carriage of Vehicles, Passengers and supplementary Freight between Southend and Calais, at an initial frequency of one service daily increasing according to demand, during the period from 1st September, 1954 to 31st August, 1964.

Application No. 289. From Eagle Aviation Ltd., of 29 Clarges Street, London, W.1. For a Colonial Coach service with Viking aircraft for the carriage of Passengers and supplementary Freight between London (Blackbushe) and Cyprus (Nicosia) with an intermediate traffic stop at Malta and intermediate technical stops at Nice and Athens, at a frequency of from one service fortnightly up to two services weekly, for a period of seven years from date of approval.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 9 Buckingham Gate, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of the route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [1909

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The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

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both junior and senior, for design, development, research, production and testing.

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Some experience of airframe design is desirable. Good salaries and prospects for suitable applicants.

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AIR TRAVEL BAGS

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Aircraft Design

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Full-scale Layout

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Department of Aeronautical Engineering

APPLICATIONS are invited for the post of lecturer in aeronautics to specialise in the teaching of undergraduate and post-graduate students in high-speed flow problems. Some experience in this field is desirable though not essential. In the absence of a suitable candidate, a lecturer specialising in aircraft structures and aero elasticity would be considered.

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Department of Aeronautical Engineering

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STAG LANE

for

SENIOR DESIGNERS
DRAUGHTSMEN AND
STRESSMEN

for work on the

DESIGN AND DEVELOPMENT OF GAS TURBINE ENGINES and other interesting projects

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Arrangements made for interview to take place locally and on Saturday mornings if necessary

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Please write in confidence, giving full details of qualifications and experience to

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THE
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STRESS ANALYSIS
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Excellent opportunities for advancement in an expanding organization.

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SUCCESSFUL APPLICANTS WILL RECEIVE GENEROUS MOVING ALLOWANCES

Application forms may be obtained from the following address and should be returned not later than April 30th. Arrangements will be made for interview in England during May.

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J. H. DAVIS
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SITUATIONS VACANT

QUEEN MARY COLLEGE (University of London), Mile End Road, E.1.
APPLICATIONS are invited for the following posts:

LECTURER or assistant lecturer in aeronautical engineering to teach mainly in the subject of aerodynamics, but an interest in aircraft structures would be an additional qualification.

LECTURER in electrical engineering. Applicants should be university graduates and should preferably have had experience in electrical power or electrical machines.

ASSISTANT lecturer in geology, with special qualifications in petrology and mineralogy, and preferably sedimentary petrology.

ASSISTANT lecturer in mathematics. Preference will be given to candidates with special qualifications in algebra or geometry.

THE appointments will date from October 1st, 1954. Salary scales: Lecturer, £600 by £50 to £900; £900 by £50 to £1,150; assistant lecturer, £500 by £50 to £600; commencing salary according to age and experience. F.S.S.U. participation and family allowance of £50 per child.—Applications forms, available from the Registrar, are returnable by May 3rd. [1905

DEVELOPMENT engineers experienced in the handling of electronic equipment for the measurement of vibration.

DUTIES: To issue instructions re testing and setting up of equipment and the interpretation of results after routine analysis has been carried out. Experience in the design of electronic equipment would be an advantage but not essential as long as applicants have experience of mechanical development and of the operation of electronic equipment. Degree or Higher National Certificate.

SALARY: £500 to £700.—Apply, Labour Manager (H), Rolls-Royce, Ltd., Derby. [1895

BRITISH EUROPEAN AIRWAYS have vacancies at London Airport for fully skilled engine fitters, airframe fitters, electricians, instrument repairers and radio mechanics.

BASIC rate of pay 3/6d. per hour, plus bonus; up to 3d. per hour proficiency pay can be earned; shift premium pay where appropriate; 44-hour week.

AFTER qualifying periods, pension and sick pay scheme, air travel concessions, 2 weeks annual holiday.

WRITTEN applications, giving full particulars, to Personnel Officer, Engineering Base, B.E.A. London Airport, Hounslow, Middlesex. [1908

Q.F.I. required with jet aircraft and Mosquito experience; latter not essential but desirable. No licences required.—Apply: Chief Pilot, Airwork, Ltd., R.N.A.S. St. Davids, Pembrokeshire. [1899

TECHNICAL representative required by progressive engineering company with large toolroom and production shop. Contacts with aircraft manufacturers essential. Good position for man with energy and initiative. State experience, age and salary.—Box 4062. [1881

SKILLED aircraft tool inspectors required by large factory in Blackpool. Good prospects for experienced men.—Apply, stating age and particulars of experience, to Personnel Officer, Hawker Aircraft (Blackpool), Ltd., South Shore, Blackpool. [1886

SENIOR and intermediate design draughtsmen, with good experience of aircraft or light structural or mechanical engineering, required for aircraft and armament project work.—Apply, by letter, to Portsmouth Aviation, Ltd., The Airport, Portsmouth. [0612

JIG and tool draughtsman (senior) required. Good welfare facilities including staff pension scheme.—Applications, in writing, to Personnel Manager, Percival Aircraft, Ltd., Luton Airport, Beds, stating age, experience and salary required. [0593

COMPETENT estimator required by large aircraft factory. Applicants must have had wide experience of estimating for aircraft repair work, both airframe and installations. Good salary and prospects.—Apply giving age and full details to: Personnel Officer, Hawker Aircraft (Blackpool) Ltd., South Shore, Blackpool. [1910

SENIOR electrical draughtsmen required to work on super priority aircraft. Considerable experience in latest types of aircraft electrical installations. Pension scheme available.—Apply, with full details, to the Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middx., quoting reference ED/1. [1888

AIRCRAFT detail and assembly inspectors with recent experience required for large factory in Blackpool. Good pay and prospects for suitable men.—Apply, stating age and particulars of experience, to Personnel Officer, Hawker Aircraft (Blackpool), Ltd., South Shore, Blackpool. [1885

ELECTRONIC engineers experienced in design, construction and operation of electronic equipment, required to work on the measurement of vibration of engines, etc. Some mechanical experience, strength of materials, etc., an advantage. Degree or Higher National Certificate. Salary, £400 to £700.—Apply, Labour Manager (D), Rolls-Royce, Ltd., Derby. [1894

ARMSTRONG SIDDELEY MOTORS require fully experienced aircraft instrument mechanic. Must be capable of Calibration of Experimental Aircraft Instruments including electrical installations (*not* radio).—Apply by letter stating experience, and qualifications, to Reference AIM, Personnel Manager, Armstrong Siddeley Motors, Coventry. [1901

TECHNICAL illustrators (male, senior) required. Considerable practical experience of illustrating for sales brochures and descriptive manuals essential. Good welfare facilities including staff pension scheme.—Applications, in writing, to Personnel Manager, Percival Aircraft, Ltd., Luton Airport, Beds, stating age, experience and salary required. [0592

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(i) GENERAL STORES CLERKS

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SITUATIONS VACANT

INTERVIEWS are offered to aircraft draughtsmen and stressmen in the London area by The English Electric Co., Ltd., at 336 Strand, W.C.2, on Saturday April 24th between 9 and 12 noon. These interviews will be in confidence and without obligation. There are opportunities for employment in the London design office and at Warton in Lancashire. [1904

H. M. HOBSON, Ltd., invite applications for positions in the drawing office as follows: designers, detail and modification draughtsmen, checkers, stressmen. The work is concerned with interesting projects connected with fuel metering equipment and hydraulic flying controls for aircraft.—Hobson Works, Fordhouses, Wolverhampton. [0420

THE ENGLISH ELECTRIC Co., Ltd., Luton, have vacancies for technical assistants of H.N.C. standard to carry out development structural tests as part of a comprehensive programme of testing on guided weapons. Previous experience of structural development or aircraft stressing an advantage.—Write to Dept. C.P.S., 336-7 Strand W.C.2, quoting ref. no. 1147F. [1858

SENIOR, intermediate and junior draughtsmen required for aircraft work of super priority. A.E.S.D. rates and upwards, depending on ability. Aircraft experience desirable but not essential. Apply giving age and details of experience and salary required to Personnel Manager, Helliwells, Ltd., The Airport, Walsall. [1821

SENIOR weights engineer required. Minimum three years' experience; O.N.C. with experience of project design work preferable. Good welfare facilities, including staff pension scheme.—Applications in writing to Personnel Manager, Percival Aircraft Ltd., The Airport, Luton, Beds, stating age, salary required, experience and qualifications. [1841

DEVELOPMENT engineers required for interesting work on the development and testing of new methods of aircraft and helicopter construction and materials. Candidates should have a university degree, Higher National Certificate or equivalent, but equally important are a broad outlook, a practical approach to engineering problems, initiative and enthusiasm. London area.

APPLICATIONS, stating age, qualifications, experience and salary required, should be addressed to Box 4583, quoting reference DE/5. [1887

CHIEF stressman required by Percival Aircraft, Ltd., Luton Airport, Beds, for work on civil and military prototype and production aircraft. Must be capable of taking full responsibility for all stressing and stress office organization.—Applications, in writing, should be made to the Chief Designer, stating age, salary required, full details of training, experience and qualifications. Pension scheme and assistance on housing available. [1880

AIR FORCE, Naval, civil and helicopter aircraft all under design and development at Percival Aircraft, Ltd., Luton Airport, Beds. Applications are invited from senior and junior draughtsmen and stressmen for work on this interesting programme. Good welfare facilities, including staff pension scheme.—Write, giving details of experience and salary required, to Personnel Manager. [0595

MECHANICAL engineering detail draughtsman required for work on small aircraft components. Applicants should have good technical training to ordinary national standard, or equivalent. Capable of working with minimum supervision.—Write, giving particulars of age, experience and salary required, to King Aircraft Corporation, Fifth Street, Montrose Ave., Hillington, Glasgow S.W.2. [1862

INSTRUMENT fitter required for strip and re-build of air-driven gyro instruments. All round knowledge of aircraft instruments desirable. Preference given to "X" licence ground engineer. Suitable candidate will be considered for working chargehand of instrument overhaul laboratory.—Apply, in first instance, by letter, to: Managing Director, Wynstruments Ltd., Staverton Aerodrome, Gloucester. [1859

HANDLEY PAGE (Reading), Ltd., The Aerodrome, Woodley, Reading, have immediate vacancy for a senior aircraft electrical draughtsman for work on an interesting new project. Only those who are fully experienced in all aspects of the work should apply, and for the successful applicant there will be suitable housing accommodation provided.—Please send full particulars of experience, etc., to the Personnel Officer. [0235

HANDLEY PAGE (Reading), Ltd., The Aerodrome, Woodley, Reading, have vacancies in their design office for senior and intermediate stressmen and weightsmen and for draughtsmen of all grades. The work is on an interesting new project and there will be scope for rapid advancement to suitable applicants.—Please send full particulars of experience, etc., to the Personnel Officer. [0236

AN attractive appointment in the London area is available for a senior engineer on the mechanical development of an interesting new aero-engine project. Applicants should preferably be between 30 and 40, with a good technical background (e.g. corporate membership of I.Mech.E. or R.Ae.S.) and must have considerable prior experience on the planning and execution of practical development programmes in a comparable field. This need not necessarily be aeronautical, e.g., a background on internal combustion engines of any type, steam turbines, pumps, or other high-class mechanical or hydraulic machinery, would be suitable. Excellent salary to the right man.—Apply to the Chief Engineer, The de Havilland Engine Co., Ltd., Stag Lane, Edgware, Middlesex. [1837

ARMSTRONG SIDDELEY MOTORS, Coventry, have vacancies for a number of designers and senior and junior draughtsmen. Although gas turbine experience is most advantageous it is not necessarily essential as training will be given in this specialized work to suitably qualified draughtsmen.—Apply in detail to Reference F.103, Personnel Manager, Armstrong Siddeley Motors, Coventry. [0200

VACANCIES exist at Percival Aircraft, Ltd., for a number of senior stressmen on both military and civil aircraft and helicopter. Applicants must be capable of taking full responsibility for either a complete aircraft or a major component. Good salary with prospects to successful applicants and the positions carry monthly staff status.—Write, stating age, full details of experience, qualifications and previous appointments held, to the Personnel Manager, Percival Aircraft, Ltd., The Airport, Luton, Beds. [1900

AERODYNAMICISTS and aeronautical engineers required for research and development establishments of Ministry of Supply, chiefly at Farnborough, Hants, Amesbury, Wilts, and Bedford, and at London headquarters. Some research or experimental experience of aircraft problems desirable. Posts in scientific officer grade require 1st or 2nd class honours degree in mathematics, physics or engineering. Salaries within ranges £470 to £855 (London), £445 to £815 (Provinces). F.S.S.U. benefits may be available. Posts in experimental officer class require minimum of Higher School Cert. (science) or equivalent, but further training in maths., physics or engineering to standard of pass degree, H.N.C. or A.F.R.Ae.S., etc., may be an advantage. Salary within ranges: experimental officer (min. age 26), £681 to £838 (London), £649 to £799 (Provinces), or assistant experimental officer, £274 (age 18) to £607 (London), £264 to £576 (Provinces). All appointments unestablished. Women's rates somewhat less. —Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C672/53A. Closing date May 1st, 1954. [1897

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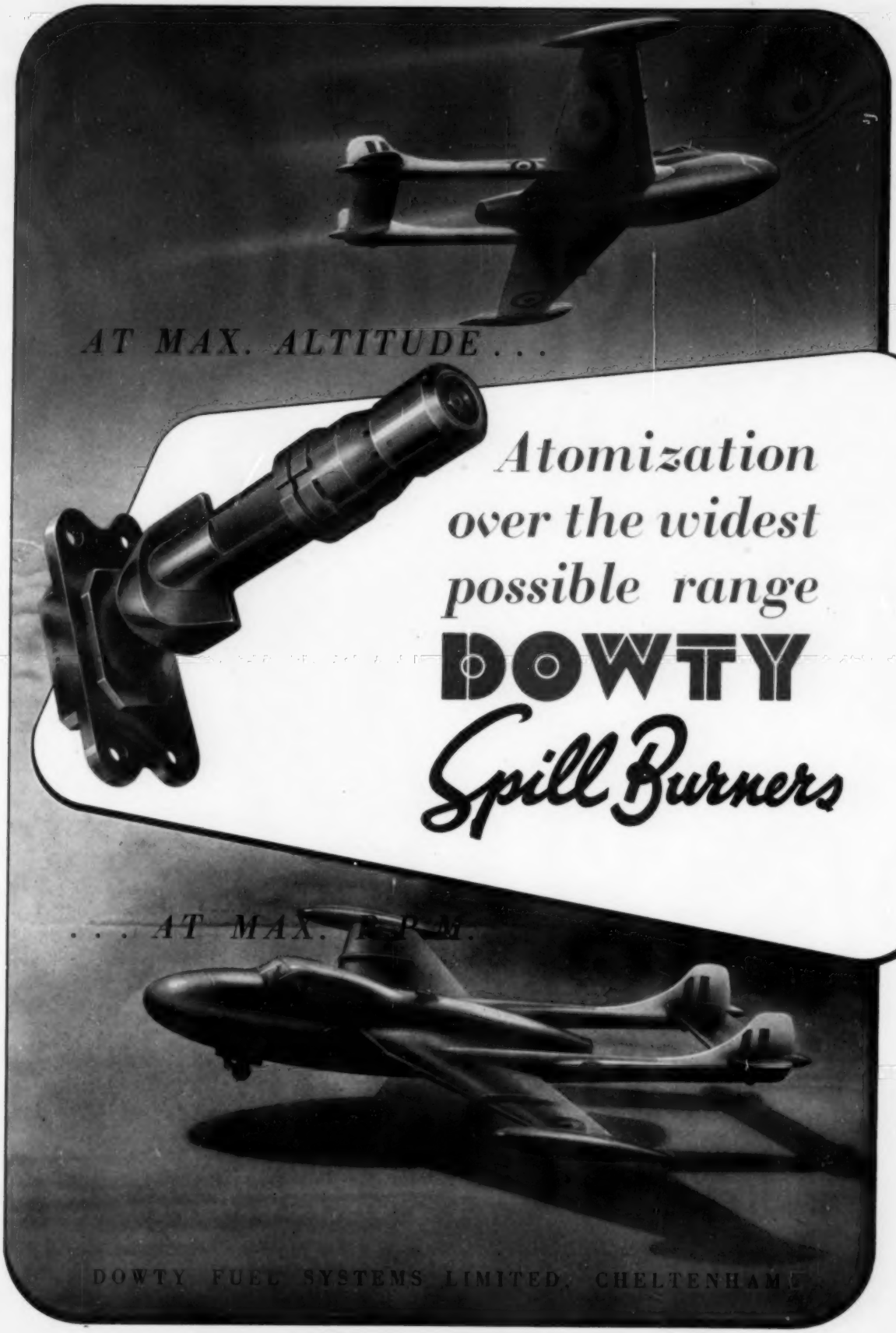
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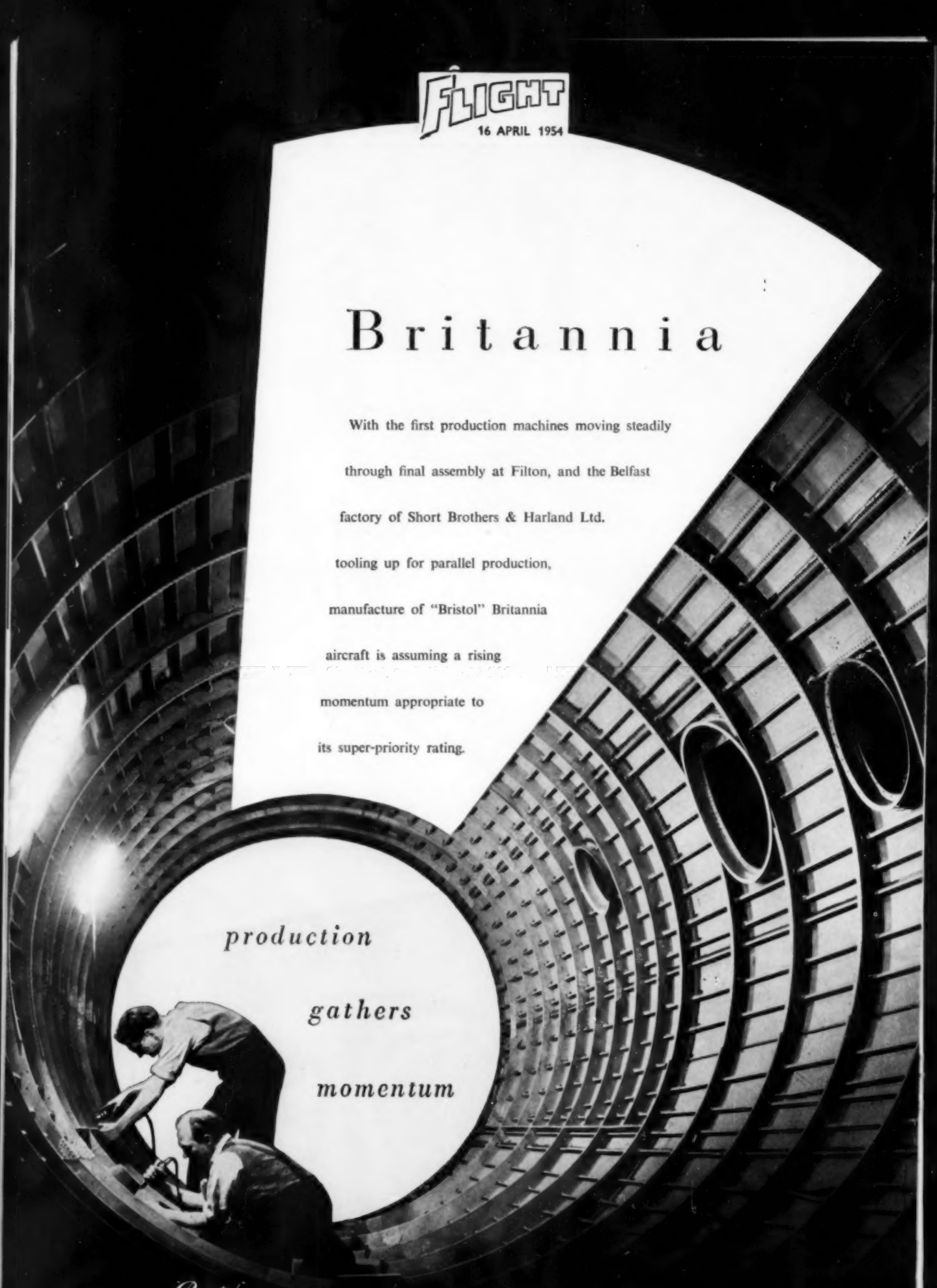

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